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WAR MACHINE

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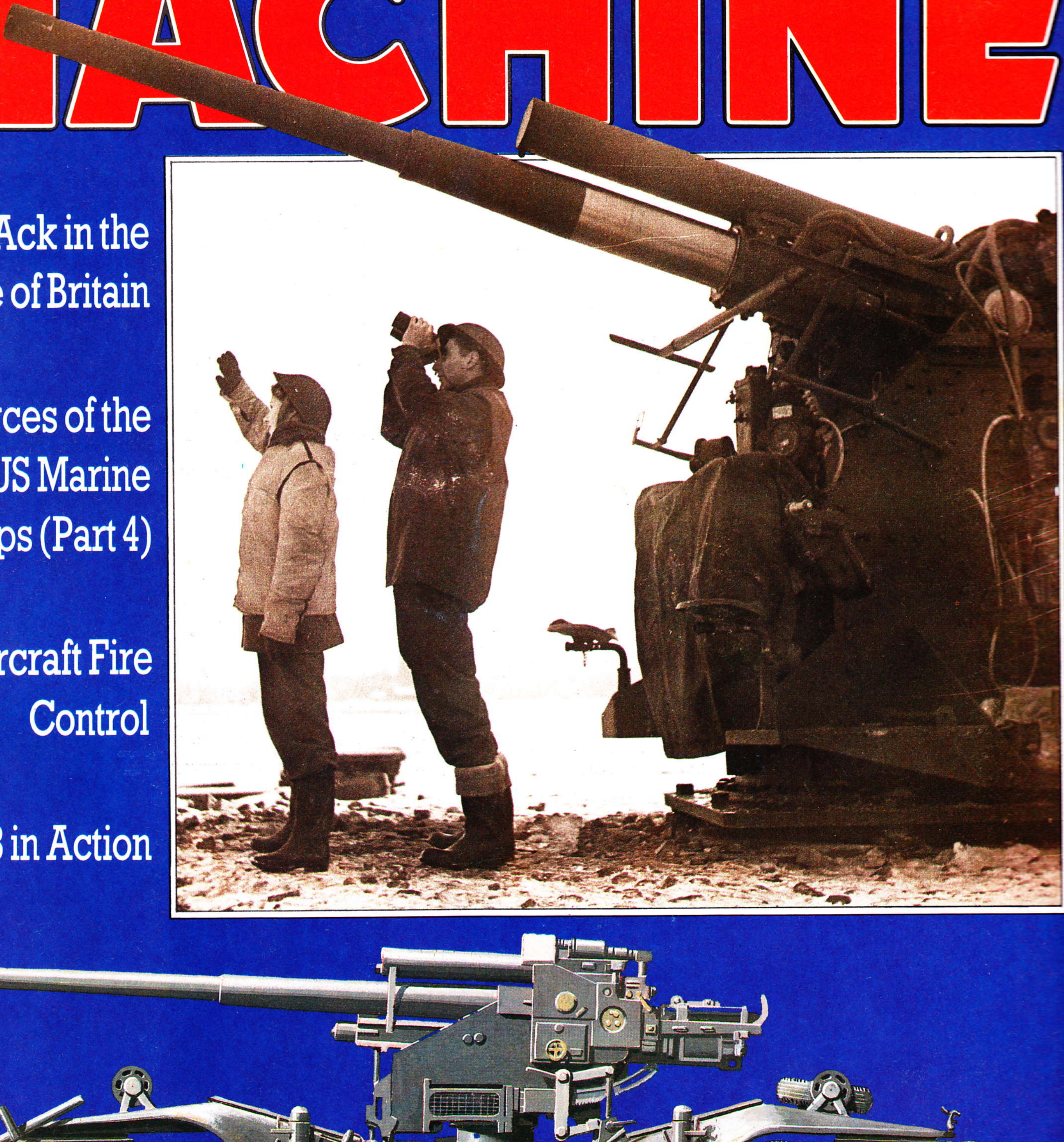

Ack-Ack in the Battle of Britain

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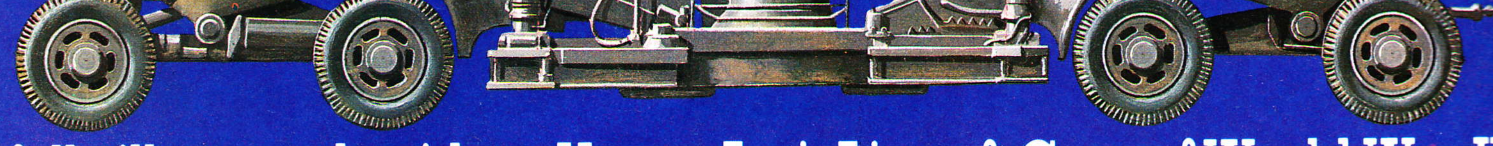
The 88 in Action



A fully illustrated guide to Heavy Anti-Aircraft Guns of World War II

WAR MACHINE

Volume 5 Issue 60

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Armed Forces of the World

US Marine Corps (Part 4) iii

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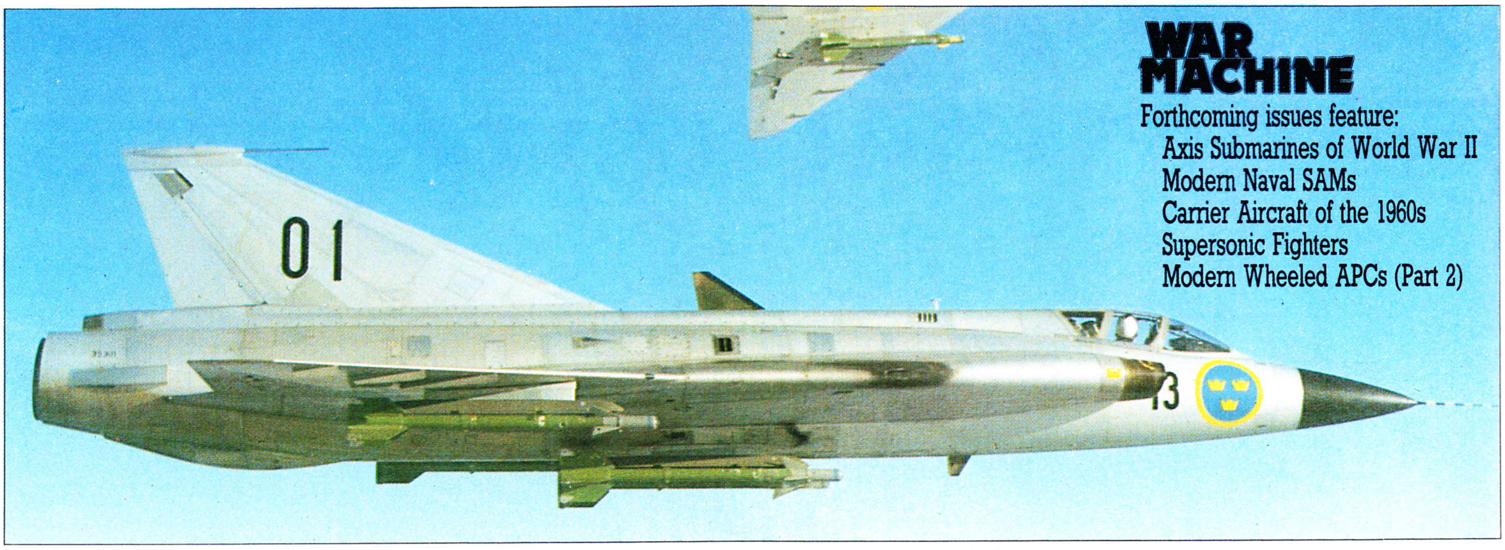

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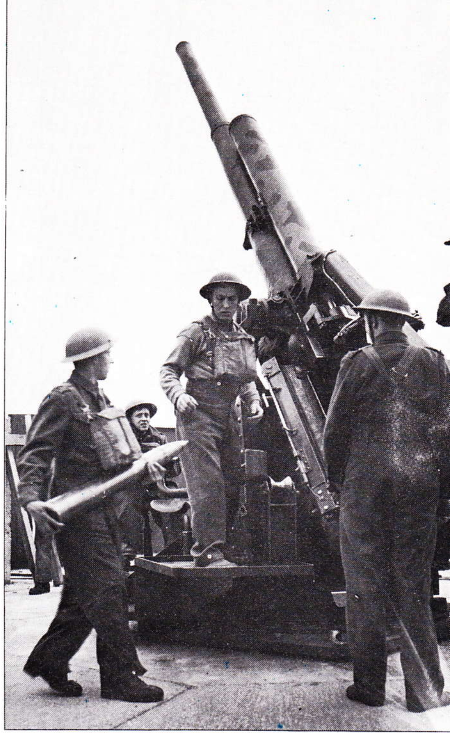
Heavy Anti-Aircraft Guns of World War II



The Battle of Britain encompassed all the many varieties of air defences. Beneath the Spitfires and Hurricanes of Fighter Command, thousands of men and women laboured to serve the anti-aircraft batteries of Britain for hours and even days at a time.

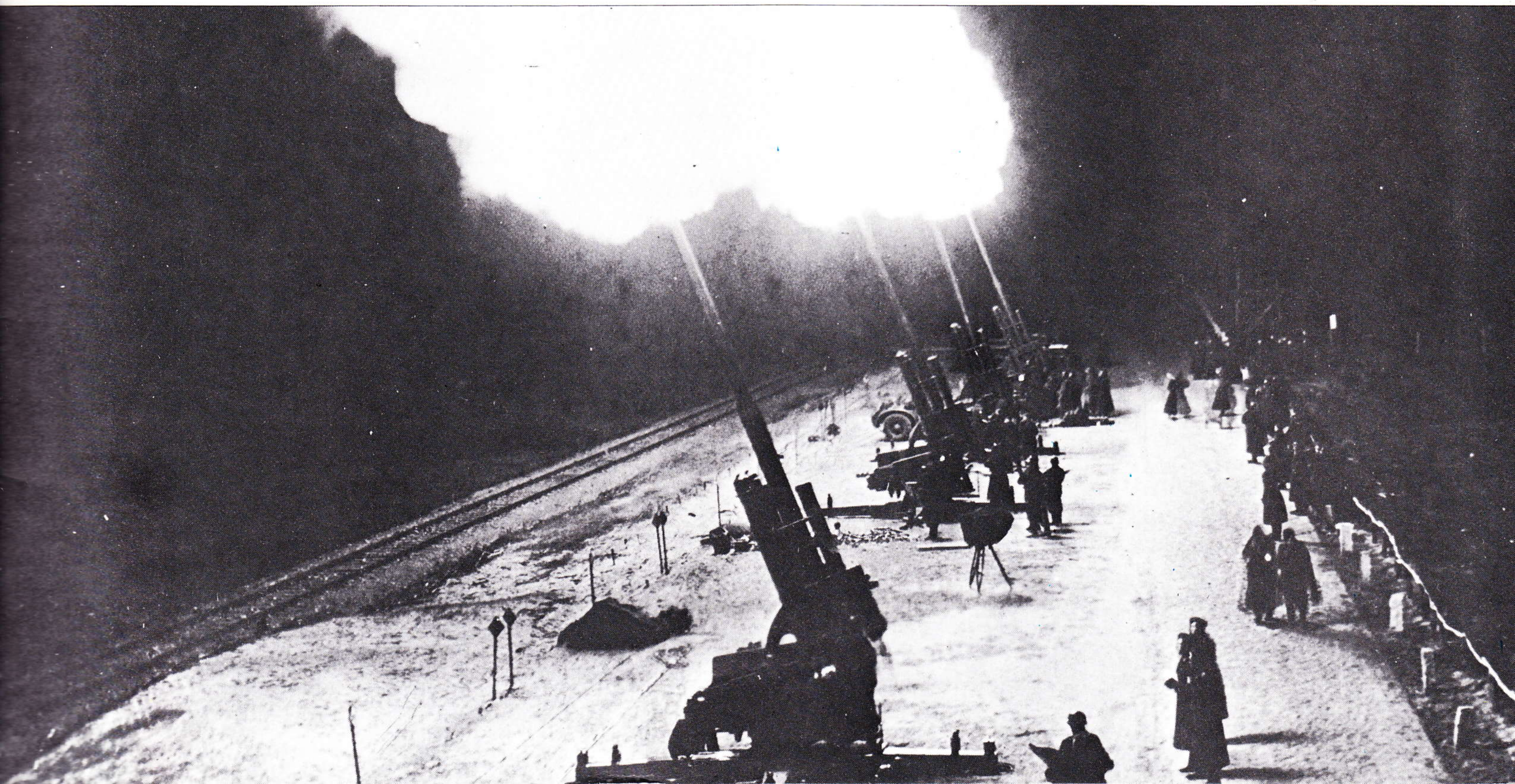
The dramatic rise in the power of aircraft between the wars saw many areas formerly safe from battle come under threat. While the major counter to high-altitude bombing was the defending fighter, ground forces also had a part to play, notably centred around the anti-aircraft gun.

World War II was both the heyday of and the scene for the last large-scale use of the heavy anti-aircraft gun. The weapon had been born during World War I, but by 1939 the heavy anti-aircraft gun was basically the same as that used in 1918, along with the fire-control systems which were little more advanced in 1939 than they had been in 1918. But although the guns appeared to be similar to the World War I weapons they had in fact been considerably advanced in performance: more powerful charges fired larger and more effective projectiles to greater heights than before and at much higher muzzle velocities. Their carriages had also been updated.

Here and there some left-overs from World War I survived, especially among the French 75-mm (2.95-in) guns. But by 1939 many of the guns in service were no longer the hasty improvisations of 1918 and earlier, but purpose-designed and purpose-built weapons of considerable power. Upon them fell the brunt of the defence of cities and field armies against air attack, and the same guns defended the important centres of communication and production. At many and diverse locations these guns stood and waited for an enemy which often never arrived, but elsewhere the enemy came in droves and the heavy anti-aircraft guns were in action for as long as their crews could load them.

Among the guns discussed here is one that has by now become almost a legend, namely the German '88'. This famous gun earned its reputation outside its design spectrum as an anti-armour weapon, but all its details are provided here along with accounts of its use in action. But as will be seen, the '88' was not endowed with magical powers; nor did it have a specification that made it differ from many other weapons mentioned in this book. It was simply the way it was used that attracted so much notoriety. Many other guns could have been used in a similar way against armour but their owners were either not so inclined or not organized to use anti-aircraft guns against land targets. They were used instead for the role for which they were designed, namely the engagement of aircraft targets in defence of a locality or installation. Most of them were able to carry out this task more than adequately, and certainly as well as any German '88'.

A German heavy battery in action in November 1939. The 12.8-cm Flak 40 guns are firing simultaneously to allow their heavy shells to 'bracket' their target. Later in the war such combinations were radar-directed, and as many as 16 heavy weapons would concentrate their fire upon a single luckless bomber.



ITALY

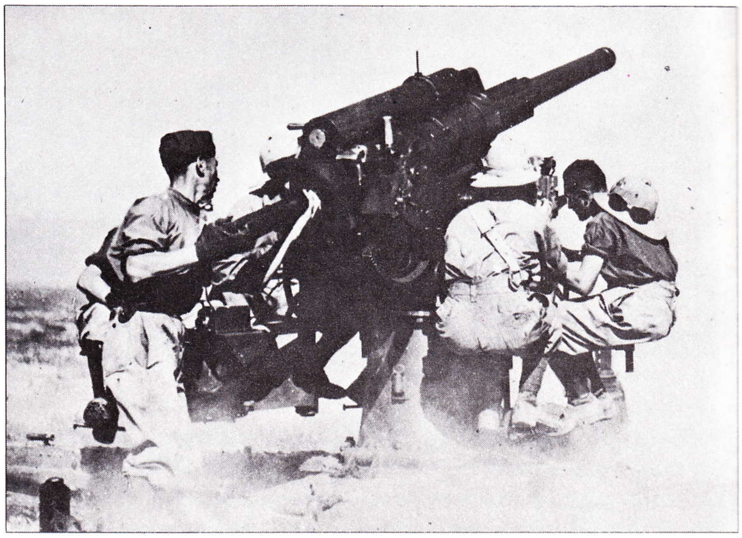
Cannone da 75/46 C.A. modello 34

Between the two world wars the Italian armaments industry produced many good designs, but not many got to the hardware stage for the Italian economy was constrained, then as now, by an overall shortage of raw materials of every kind. Thus before any new weapon design was introduced into service it had to be vetted carefully to ensure that it was as good a design as possible to justify the expenditure involved. So when Ansaldo produced a new anti-aircraft gun in 1926 it was examined over a long period before production was authorized, and it was not until 1934 that the gun was actually in service.

The new gun was the **Cannone da 75/46 C.A. modello 34** (75/46 denoting the calibre of 75 mm and the barrel length of 46 calibres). In overall design the 75/46 was a sound though unremarkable effort that owed much to the influence of the contemporary Vickers designs produced in the United Kingdom. This was especially apparent in the carriage design, with a central pivot on which the gun saddle swivelled and a folding cruciform platform. On the move the platform legs were folded together, leaving the pivot resting on a two-wheeled carriage arrangement. When the equipment was ready for emplacement, the legs were swung forward and the wheels removed once the load had been taken by the centre of the carriage. The arrangement of the ordnance on the carriage was very simple and straightforward, and the fire-control instruments on the carriage were simple but adequate.

As always for the Italian armaments industry, the main problem with the 75/46 was one of production. Despite ever-increasing demands from the field, production was slow and erratic. Initially 240 equipments were ordered, but even by the end of 1942 only 226 had been delivered. Not all of these were used primarily as anti-aircraft guns, some being emplaced as dual-purpose anti-aircraft and coastal defence guns at selected points. This meant that many of the rather ancient AA weapons in use at the time had to be retained well past their planned replacement dates. Things were not helped greatly by the diversion of some finished barrels for use in *semovente* (tracked assault gun) mountings.

Despite this dispersion of effort, the 75/46 was spread as thinly as possible for home defence of the Italian mainland and the North African territories. When Italian army units moved to serve on the Eastern Front they took a further 54 guns with them, leaving even fewer to defend Italy. But even these guns were destined to follow a varied service career, for in 1943 after the Italian surrender the guns still around were taken over by German occupation forces. The 74/46 then became the **7.5-cm Flak 264/3(i)**, but the type was not used by the Germans outside Italy other than in some of their anti-Yugoslav partisan operations. Even this change of hands did not mark the end of the ownership list for the 75/46, for following the Allied invasion of the Italian mainland numbers were captured by the advancing Allied armies and eventually used in a coastal defence role around such ports as Naples.



This Cannone da 75/46 C.A. Modello 34 is in action against Allied aircraft flying over Libya. This Ansaldo gun was the standard Italian anti-aircraft gun; it was used on all the Italian fronts and was a good all-round performer, but could not be supplied in the quantities required.

Specification

Cannone da 75/46 C.A. modello 1934
Calibre: 75 mm (2.95 in)
Weight: travelling 4405 kg (9,711 lb) and firing 3300 kg (7,275 lb)
Dimensions: length overall 7.4 m (24 ft 3 in); width 1.85 m (6 ft 0.8 in); height 2.15 m (7 ft 0.6 in); length of barrel 3.45 m (11 ft 3.8 in); length of rifling 2.844 m (9 ft 4 in)
Elevation: +90°/−2°
Traverse: 360°
Maximum effective ceiling: 8300 m (27,230 ft)
Shell weight: 6.5 kg (14.33 lb)
Muzzle velocity: 750 m (2,461 ft) per second

ITALY

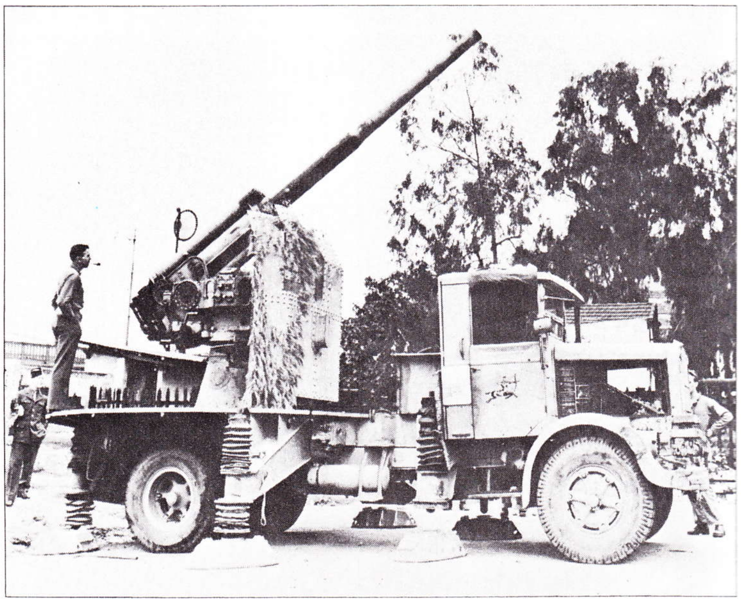
Cannone da 90/53

Of all the anti-aircraft guns in service with the Italian army from 1941 to 1943 none was better than the **Cannone da 90/53**. It was an excellent weapon that could stand comparison with any of its contemporaries, and it was a good, sound and modern design. It was another product of the Ansaldo design team and the first examples were produced during 1939. Production was authorized in three main versions.

The most numerous version of the 90/53 was supposed to be the **modello 41P** intended for static emplacement only; 1,087 examples of this version were ordered. A further 660 examples of the towed **modello 41C** were ordered, while another order was for a further 57 guns to be mounted on a variety of heavy trucks (**autocannoni da 90/53**). A later order requested yet another batch of barrels (30) for mounting on self-propelled tracked mountings.

Ordering these weapons was one thing, but producing them was quite another, and the final production figures never reached the original optimistic totals. By July 1943 only 539 weapons of all variants had been delivered, but by then the production line was in German hands and continued for German use alone. German formations in North Africa had already had the 90/53 in their service for some time, for they recognized it as a very good gun comparable with their own '88'. At first sight the 90/53 resembled the 8.8-cm (3.465-in) Flak 18 and Flak 37 weapons, but there were many differences and the similarities were only superficial. The 90/53 had a pivot carriage mounted on a cruciform platform, but on the carriage itself the arrangement of the fire-control instruments was quite different from those of the German guns and the barrel was of one-piece construction instead of the multi-section arrangement of the later German guns.

The Italians used the 90/53 as a multi-purpose weapon on occasion, but some were emplaced as dual-purpose anti-aircraft/coast defence weapons. At times they were used as long-range field guns and the performance of the gun was such that it could match the German '88' as an anti-armour weapon. Numbers were also diverted to the Italian navy. The Germans valued the 90/53 so highly that following the Italian surrender of 1943 they impressed as many 90/53s as they could find. Many of them were sent back to Germany for the defence of the Reich as the **9-cm Flak 41(i)** though the official designation was **9-cm Flak 309/1(i)**, and by December 1944 315 such equipments are mentioned in German records, though many of these would no doubt have been emplaced in Northern Italy. Numbers of 90/53s also fell into Allied hands during their advance north through Italy, and many of these were impressed for the coast defence role by British coastal batteries around the main captured ports.



This Cannone da 90/53 is rendered mobile by mounting on a Autocarro Pesante Lancio 3/RO heavy truck. The gun is seen here fitted with a protective shield for the gun crew in action, and very noticeable are the outriggers used to stabilize the gun when firing. Only a few of these combinations were made.

Specification

Cannone da 90/53
Calibre: 90 mm (3.54 in)
Weight: travelling 8950 kg (19,731 lb) and firing 6240 kg (13,757 lb)
Dimensions: length 7.60 m (24 ft 11.2 in); width 2.30 m (7 ft 6.5 in); height 2.50 m (8 ft 2.4 in); length of barrel 4.736 m (15 ft 6.5 in); length of rifling 4.046 m (13 ft 3.3 in)
Elevation: +85°/−2°
Traverse: 360°
Maximum effective ceiling: 12000 m (39,370 ft)
Shell weight: 10.33 kg (22.77 lb)
Muzzle velocity: 830 m (2,723 ft) per second

Anti-Aircraft Fire Control

It may seem strange, considering the resources devoted to ground-based defences during World War II, but the chances of an aircraft actually being hit by a heavy anti-aircraft shell were remote. Strenuous efforts were made to alter this situation, notably in the area of fire control and targeting.

One of the most difficult of all artillery targets to hit is an aircraft in flight. There are several reasons for this, not the least being that the aircraft is free to move in any one of three planes as its pilot wishes. Another is that projectiles fired from any gun take time to reach their destination and by the time they arrive at the point at which they are aimed the target may well have moved from its previous course in any direction. Thus the anti-aircraft gunner has to use a great deal of special equipment in order to get his weapon, the projectile, as close to his target as possible.

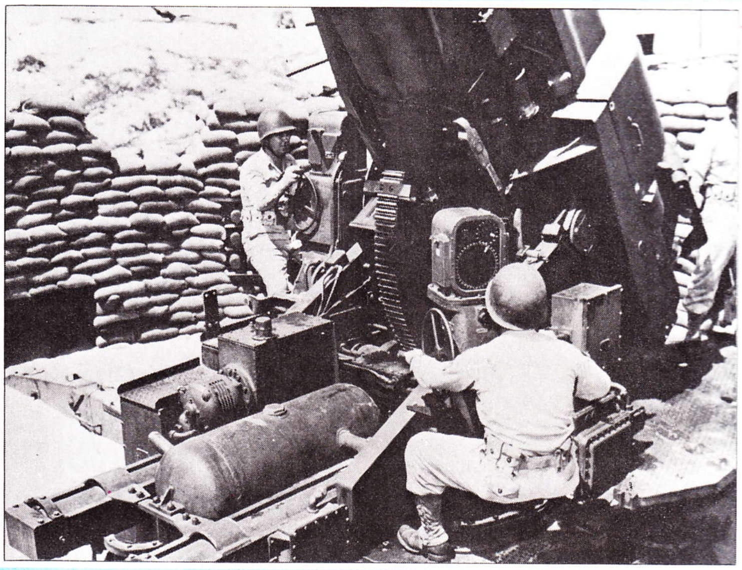
Much of what is contained here has now been rendered obsolete by the advent of radar, the guided missile and the silicon chip, but the gunner of World War II initially had none of these. In their place they had to rely on a number of mechanical contrivances, all of which relied on one basic precept: that for the guns to have any sort of a chance of hitting anything the target had to remain flying on a set course at a constant speed. It is very rare for aircraft to fly in this fashion and even massed bomber formations tend to leave some leeway for individual aircraft to bob and weave, but there was no alternative for the gunners but to make this 'constant path and speed' assumption.

Nearly all but the largest anti-aircraft guns had some form of on-carriage fire-control system in the form of a simple 'cartwheel' sight for use when operating in isolation or in an emergency. Under such conditions range information was derived from a simple form of portable range-finder, but for useful accuracy the optical base of such an instrument has to be as wide as possible, so even in the early days range data were usually derived from a wide-base rangefinder located in the centre of a gun position and shouted or telephoned to the guns. Once this central position was an accepted fact it then became easier to conceive the idea of using this central position to derive other gun-control data. Thus in place of the on-carriage sight the predictor was developed. In the early days of World War II this was a purely mechanical device into which target information (range, heading, wind speeds etc) was fed manually. The resultant fire-control data could then be read off from dials and fed to the guns by voicé, either simple shouting or by telephone. As time went on the predictors became more complicated and cables were used to transmit the control data direct to the guns. There it was initially read off from dials and then applied to the gun controls but even this was eventually bypassed, first by a system of 'follow-the-pointer' or the alignment of flashing lamps, and then by a fully automatic system in which the gun layers had little to do other than supervize the operation. Again, in time this data transmission was extended to other factors such as fuse setting. Most anti-aircraft projectiles were HE shells that relied on a time fuse to set off the main charge when it was near the target, the chances of hitting an aircraft target being too remote for anything else. But in the time it took to set these time fuses manually the target information might well have changed, so the 'dead time' it took to set the fuse and to load and fire had to be as short as possible. In time this was reduced by the use of centrally-controlled or automatic fuse setting machines first on the gun carriage and then actually on the loading tray so that the fuse was set only as the round was fed into the gun breech.

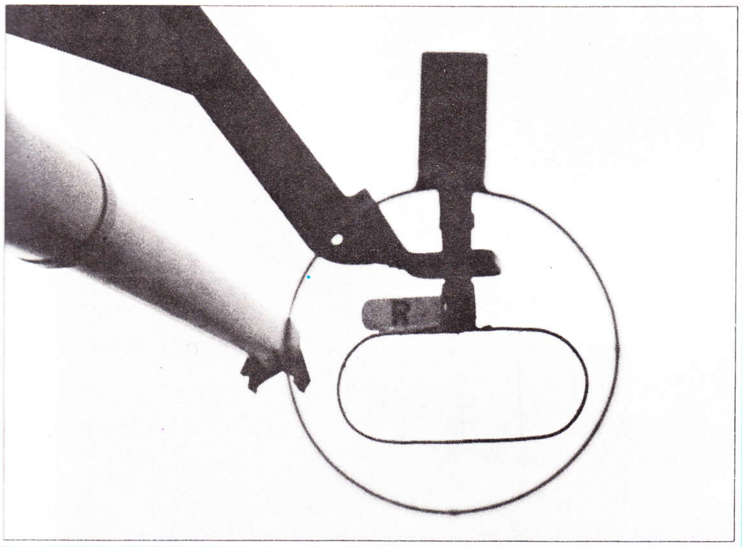
The fuses themselves were small wonders of manufacturing skill and were expensive to produce, even when mass produced. Early in the war most relied on some form of clockwork, but later some electrical and even electronic timers were in service. For real technological wonder the best of all the anti-aircraft fuses was the proximity fuse, for which the body of the shell acted as a miniature radar transmitter and signals reflected from the target were detected by the fuse itself. If these signals reached a certain level the target was in range and the shell detonated. By the use of such fuses the V-1 flying bombs were finally defeated, but even without such fuses the V-1s formed a perfect anti-aircraft gunner's target. They flew along a fixed course at a constant altitude and speed until the final moment before falling, and were thus ideal candidates for the well-established predictor/rangefinder methods of fire control.

By the time the war ended both the Allies and the Germans were using various forms of radar for fire control. Radar took a lot of the guesswork out of target prediction as it could accurately track both course and altitude, while the advent of what we now know as the electronic computer made prediction as accurate as it could be. But by then the aircraft targets were flying higher and faster and no matter how high the muzzle velocity of the gun became it still took an appreciable time for the shell to reach the target altitude. It was a problem that could only be overcome in the usual manner, the application of masses of fire and large projectiles that could carry as powerful an explosive payload as possible.

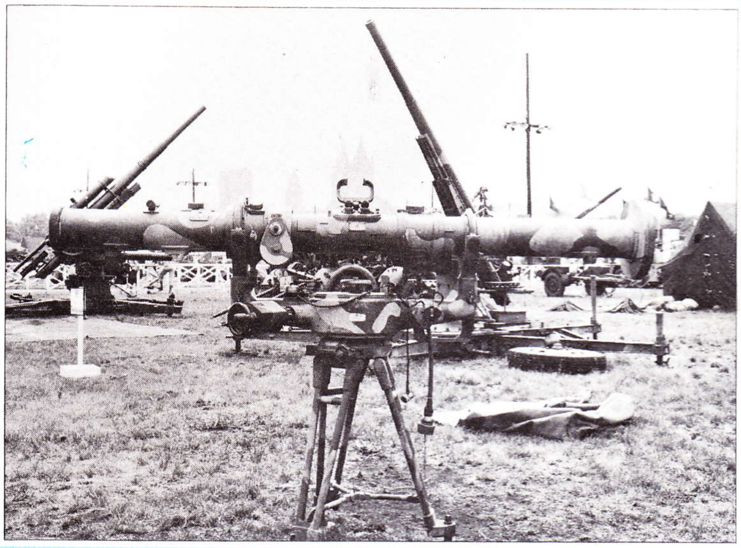
It was a problem that was not solved until the advent of the guided missile. By the time that the last anti-aircraft guns for large-scale defence were removed during the 1960s there were large-calibre guns that could fire massive shells to unprecedented heights at the rate of at least one per second, but somehow the attacker could still survive it all statistically.



The American 120-mm M1 anti-aircraft gun had two gun aimers. One layer would be concerned with the elevation control (on the left in the photograph) and the other with the traverse (on the right). On some similar guns another layer would be controlling the fuse setting machine.



The simple wire sight, seen here on a French 75-mm gun, was standard on most AA weapons, for use in emergency or when operating in isolation away from more sophisticated fire control equipment. With aircraft flying ever faster and higher, new methods had to be developed.



Typical of many World War II rangefinders is this Japanese example with a two-metre optical base. This would be used by one person, with another checking readings and transmitting them verbally to a central fire control point. These expensive instruments were usually distributed one to a battery.

JAPAN

Type 88 75-mm anti-aircraft gun

The 75-mm (2.95-in) **Type 88 Mobile Field AA Gun** was a Japanese army weapon introduced into service in 1928. At that period the Type 88 was as good a gun as any in service, and was well capable of tackling the aerial targets then likely to be encountered. But it was soon overtaken by increases in aircraft performance, to the extent that it could at best be described as an efficient but indifferent performer.

The Type 88 design was chosen after an examination of other current and prospective anti-aircraft guns, and was an amalgam of some of the better points of several weapons. The barrel was a single-piece design with a sliding breech and mounted on the then-fashionable central pivot. The firing platform had five legs which folded fore and aft for transport, and to assist the overall balance on the move the barrel was partially retracted. In action each outrigger leg was supported on an adjustable foot for levelling and there was another adjustable foot under the central pivot. A central pair of wheels was used to tow the gun along roads, these being removed before firing.

Like so many other contemporary Japanese weapons, the Type 88 was difficult to produce as virtually everything on the gun had to be hand-made. It gradually became the standard Japanese army anti-aircraft gun and at one time or another was used by every army field formation, starting in China and Manchuria during the 1930s. It was also widely used during the early Japanese advances in the Pacific. However, once the Japanese mainland came increasingly under threat of air attack from 1943 onwards the Type 88s were gradually withdrawn from the more outlying island garrisons and sent to the home islands. Their places were taken by a motley array of diverse weapons, mainly ex-naval pieces dug into improvised land emplacements.

Back in Japan the Type 88 soon demonstrated that it suffered from a low maximum effective ceiling (the altitude to which the projectiles could be fired to engage an aircraft target for a useful amount of time). For the Type 88 this was about 7250 m (23,785 ft), and on many occasions Boeing B-29 bombers could operate at well above this altitude. But for the Japanese it was the Type 88 or nothing, for as always they lacked the large manufacturing base and design experience to produce anything better in the time available. Instead they had to impress all manner of modified naval guns for the home defence role and even resorted to the use of simple mortars for low-level defences in some areas.

The Type 88 is mentioned in some Allied intelligence reports as having an anti-armour role, but there appears to be little (if any) evidence of the Type 88 being used in this role. A special armour-piercing projectile known as the Type 95 was produced for use by the Type 88, but the usual high explosive projectile was the Type 90.

Specification

Type 88

Calibre: 75 mm (2.95 in)

Weight: travelling 2747 kg (6,056 lb) and firing 2443 kg (5,386 lb)

Dimensions: length travelling 4.542 m (14 ft 10.8 in); width 1.951 m (6 ft 4.8 in); height 2.019 m (6 ft 7.5 in); length of barrel 3.315 m (10 ft 10.5 in); length of rifling 2.578 m (8 ft 5.5 in)

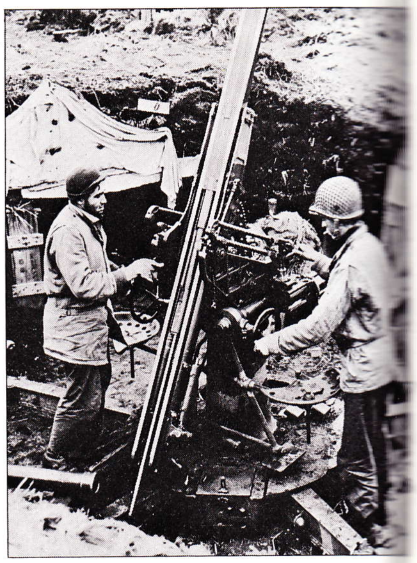
Elevation: +85°/−0°

Traverse: 360°

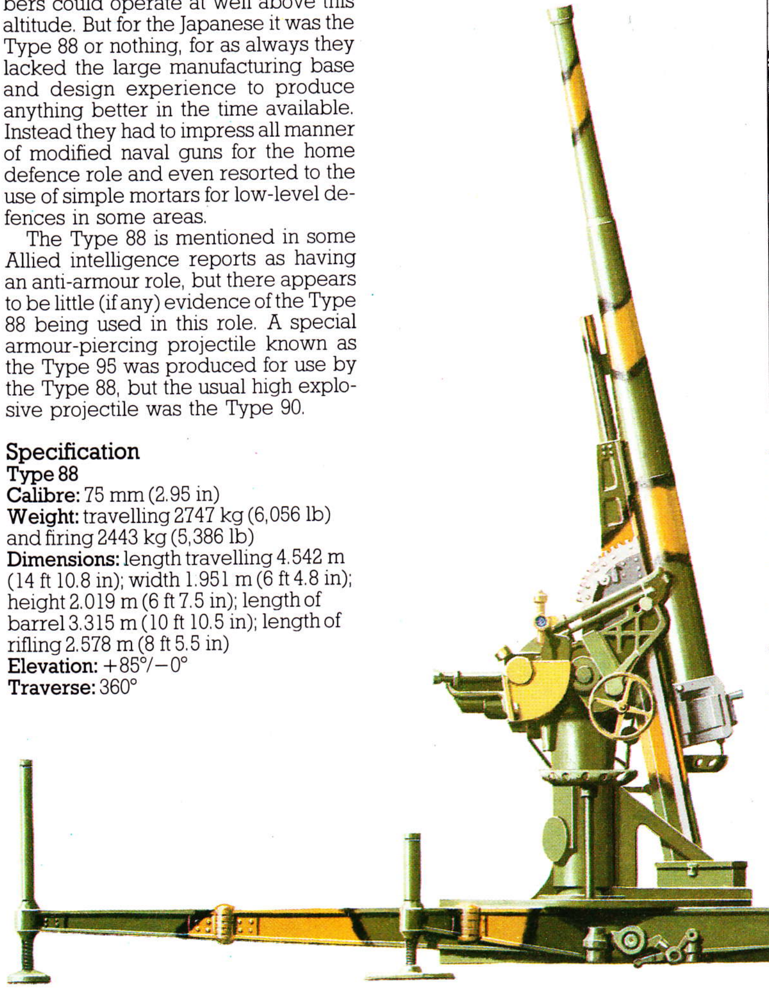
Maximum effective ceiling: 7250 m (23,785 ft)

Shell weight: 6.58 kg (14.5 lb)

Muzzle velocity: 720 m (2,362 ft) per second



Above: The mount of a captured Type 88 75-mm gun is examined in the Pacific. Notice the five legs of the firing platform and the detached barrel at the bottom left of the photograph.



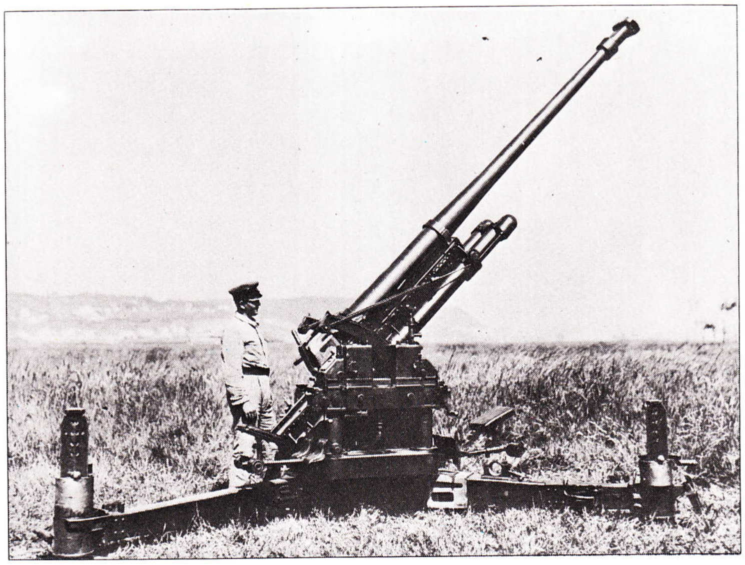
Left: An emplaced 75-mm (2.95-in) Type 88 anti-aircraft gun. This Japanese gun should not be confused with the German 88, for the Japanese Type 88 referred to the year of introduction according to the Japanese calendar and not to the calibre, as with the German gun; the two had very little in common.

FRANCE

The French 75-mm guns

When the problem of anti-aircraft defences arose during World War I the French army reacted in its usual manner, taking the ordnance of the famous '75', the mle 1897 field gun, and placing it onto a simple high-angle mounting. There were several of these mountings, one being a simple arrangement of the gun on a fixed turntable with the carriage knocked up from steel assemblies. This simple arrangement was the **Canon de 75 mm anti-aérien mle 1915**, but a better arrangement was produced by the **Canon de 75 mm anti-aérien mle 1913**, which was an early attempt to produce a self-propelled anti-aircraft gun by mounting a mle 1897 on a truck. Despite the early design date this turned out to be a remarkably good anti-aircraft weapon but it was not the only use of the mle 1897 for the role. There was also a **Canon de 75 mm contre aeronefs mle 1917** which was a towed piece but one in which all the fire-control instruments were mounted on the carriage; this was a Schneider design.

These three equipments were still in use in appreciable numbers in 1939 when World War II began for the simple reason that there appeared to be no real need to replace them; moreover, funds for new equipment for the French army were scant while the Maginot Line was being constructed. However, by the late 1920s it was appreciated that the old mle 1897 field gun was being rapidly outmoded as an anti-aircraft weapon and that higher-velocity weapons would soon be needed. Thus there started a desultory programme of re-equipping the many old batteries. Some of the first to be updated were the fixed batteries around such locations as Paris, where the old fixed mle 1915 equipments simply had their barrels replaced with a more powerful Schneider ordnance to produce the **Canon de 75 mm contre aeronefs mle 17/34**. This new barrel provided a much better performance with less time-of-flight and improved service ceiling. Similar barrels were placed on the old mle 1913 truck-mounted equipments and also on the almost-as-old mle 1917 equipments, but so slow was this gradual rebarrelling programme that many guns still had their original mle 1897 barrels in



The Canon de 75 mm mle 1936 was a Schneider design produced only in small numbers. This example was captured in North Africa from the Vichy French in 1943.

The French 75-mm guns (continued)

1940.

Some completely new equipments were produced during the 1930s. Using the new Schneider barrel a completely new anti-aircraft gun known as the **Canon de 75 mm contre aeronefs mle 1933** was produced during the mid-1930s. This was an odd-looking gun mounted in action on a cruciform platform with the barrel trunnions mounted well down the barrel near the breech; 192 equipments were in service in 1940. Another totally new Schneider weapon was produced in two forms as the **Canon de 75 mm contre aeronefs mle 1932** and **1936**, which differed only in detail. This was a thoroughly modern weapon designed from the outset for mobility. The mle 1932 had a crew of nine men and could fire up to 25 rounds per minute. On the road it could be towed at speeds of up to 40 km/h (24.85 mph).

When the Germans invaded in May 1940, the French army was thus still in a state of confusion regarding anti-aircraft guns. The planned programme of replacement of the old weapons was still far from complete, and many guns still had their obsolete mle 1897 barrels. There were really too many types of guns in service for logistical comfort but in the event the advances of May and June 1940 swept the French army away before the anti-aircraft guns could make any impact on the Luftwaffe. Huge amounts of French 75-mm (2.95-in) anti-aircraft equipment were captured by the Germans, who took over many for their own use – but not the old mle 1897s, which were removed from their carriages and were later used as beach defence weapons in the Atlantic Wall. However, many of the more modern Schneider guns were still in German use in 1944. The designations were **7.5-cm FK 97(f)** for the 75-mm anti-aérien, **7.5-cm Flak M.17/34(f)** for the mle 17, **7.5-cm Flak M.33(f)** for the mle 1933, and **7.5-cm Flak M.36(f)** for the mle 36.

Specification

Canon de 75 mm contre aeronefs mle 1932

Calibre: 75 mm (2.95 in)

Weight: travelling 5300 kg (11,684 lb) and firing 3800 kg (8,377 lb)

Dimensions: length travelling 6.95 m (22 ft 9.6 in); width travelling 1.5 m (4 ft 11 in); length of barrel 4.05 m (13 ft 3.5 in); length of rifling 3.25 m (10 ft 8 in)

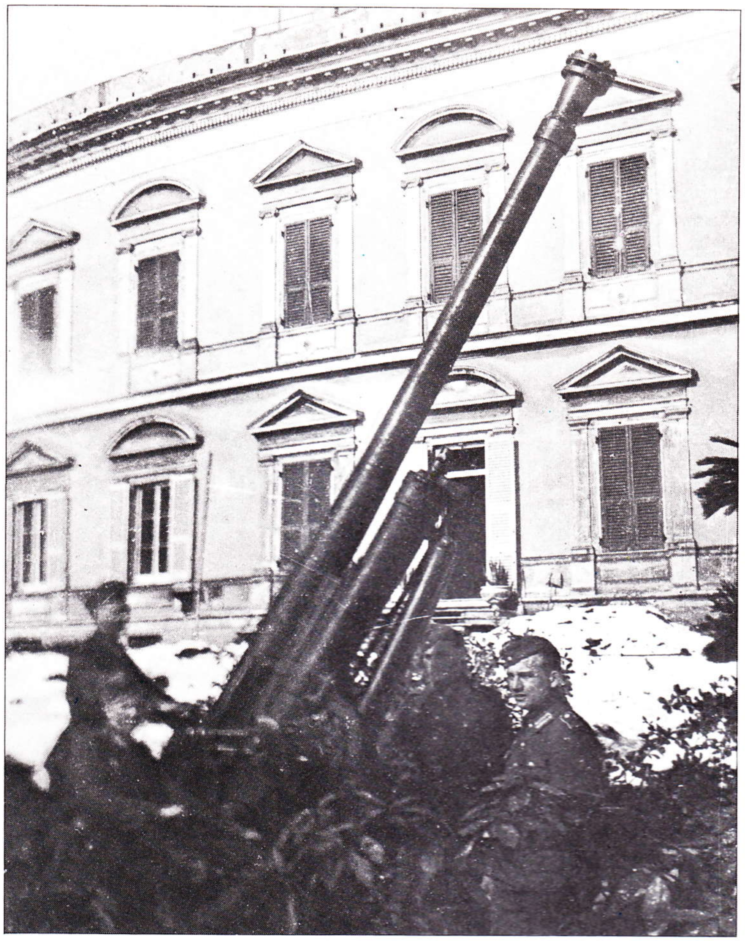
Elevation: +70°/−5°

Traverse: 360°

Maximum ceiling: 8000 m (26,245 ft)

Shell weight: 6.44 kg (14.2 lb)

Muzzle velocity: 700 m (2,297 ft) per second



The Germans were always short of anti-aircraft guns, and used as many ex-French guns as they could. This gun in German hands is a 75-mm mle 1933 formed by placing a modernized Schneider barrel onto a revised and updated World War I carriage. At one time the Germans had 160 of these in service.

SWEDEN

Bofors 75-mm and 80-mm Model 1929 and Model 1930

The widely acknowledged success of the 40-mm Bofors gun has tended to overshadow the fact that the Swedish company of Bofors also made a larger and quite successful 75-mm (2.95-in) anti-aircraft gun. The Bofors concern has always been insistent that this gun was evolved by the company alone, but it cannot be overlooked that the design was being formulated at a time when Bofors was working in close association with the Krupp team resident in Sweden as a means to avoid the terms of the Versailles Treaty. It now seems almost certain that some form of cross-fertilization occurred between the two teams, for almost at the same instant the Krupp team produced a 75-mm (2.95-in) gun that led eventually to the famous German '88' and Bofors produced its 75-mm (2.95-in) **Model 1929**.

The Model 29 differed in many details from the Krupp 75-mm (2.95-in) design, but the two weapons had a very similar performance. Other similarities were that both used a cruciform carriage with a central traverse, and that both guns used barrels of similar length and construction. But whereas the Krupp gun was used in only limited numbers by the German navy and a few South American states, the Bofors model was adopted by the Swedish armed forces in two versions.

There were two main models of the Bofors gun, the Model 29 and **Model 30**. These differed only in detail, but to confuse matters both were produced for export in calibres of 75 mm and 80 mm (2.95 in and 3.15 in). Export versions were sold to Argentina, China, Finland, Greece, Hungary, Iran and Thailand, some in 75-mm (2.95-in) and some in 80-mm (3.15-in) calibre. One of the largest customers was Hungary, which received 80 mm guns; these were used extensively during the period when the Hungarian army was allied with the Germans along the Eastern Front from 1941 to 1944, and more were retained for home defence. In Hungary the Model 29 was known as the **8-cm 29 M**. Another 80-mm (3.15-in) customer was the Dutch East Indies, but few of these weapons survived after 1942.

The Bofors gun was a sound but unspectacular performer. It used a cruciform firing platform that was lowered to the ground from two wheeled axles, which were then completely removed before firing. A horizontal breech block mechanism was fitted, and this was virtually the same as that used on the Krupp gun. However, the Bofors gun did have one thing that the Krupp design lacked, namely an overall simplicity of design: the Bofors gun had little of the complicated fire-control equipment that was used on the Krupp design and proved to be easy to operate, even in the hands of relatively untrained personnel. Thus when the Bofors gun was used in China it proved to be remarkably effective, and the type was chosen for its overall simple approach by such armed forces as those in the Dutch East Indies, which had to rely on a personnel force with few technical assets. Overall, the Bofors gun was a sound gun but one that was soon outperformed by later designs.

Specification

8-cm 29 M

Calibre: 80 mm (3.15 in)

Weight: travelling 4200 kg (9,259 lb) and firing 3300 kg (7,275 lb)

Dimensions: barrel length 4.0 m (13 ft 1.6 in)

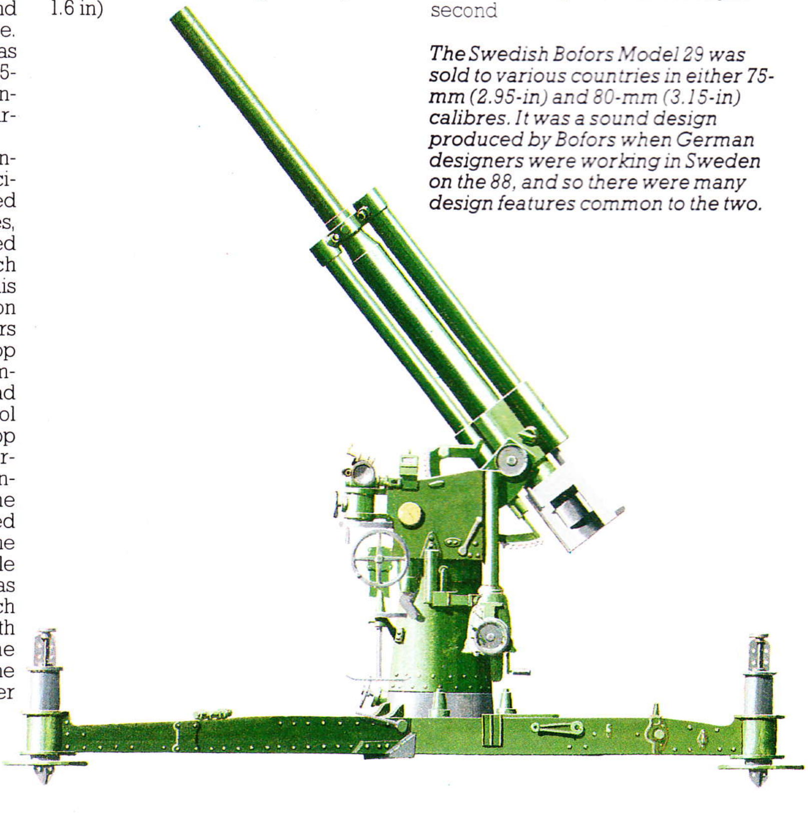
Elevation: +80°/−3°

Traverse: 360°

Maximum effective ceiling: 10000 m (32,810 ft)

Shell weight: 8 kg (17.6 lb)

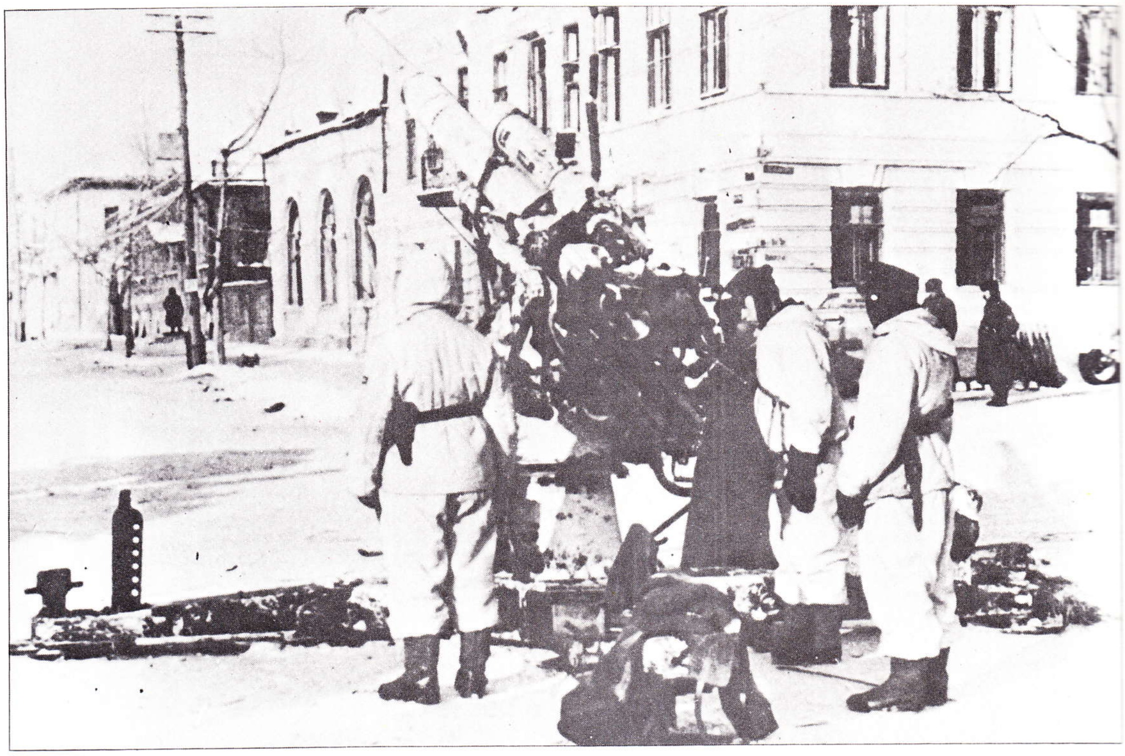
Muzzle velocity: 750 m (2,461 ft) per second



The Swedish Bofors Model 29 was sold to various countries in either 75-mm (2.95-in) and 80-mm (3.15-in) calibres. It was a sound design produced by Bofors when German designers were working in Sweden on the 88, and so there were many design features common to the two.

GERMANY

8.8-cm Flak 18 and Flak 37



This Flak 36 is seen in action during the Soviet campaign. After the tribulations of the bitter winter of 1941, the German army had become more familiar with sub-zero fighting, but 'General Winter' was still a potent contributor to the Soviet war effort.

The terms of the 1919 Versaille Treaty laid down strict guidelines as to what artillery production could be be carried out in Germany, so the largest German armaments company, Krupp of Essen, sent a team to Sweden to carry on research and development outside the imposed restrictions. Working with Bofors the Krupps team worked initially on a 75-mm (2.95-in) anti-aircraft gun using clandestine German army funds, but the army was not particularly happy with the result and asked for something heavier. The 'Swedish' Krupp team accordingly produced a new and advanced 88-mm (3.465-in) gun that by 1933 was in series production at Essen as the NSDAP came to power.

This new gun was the **8.8-cm Flak 18** (Flak standing for *Fliegerabwehrkanone*, or anti-aircraft gun), and it was an immediate success. It was a long-barrelled gun mounted on a pivoted cruciform carriage which was in turn carried on the move by twin axles that allowed the gun to be rapidly placed into the firing position. The Flak 18 had a one-piece barrel but was later supplemented by an improved version, the **8.8-cm Flak 36**, which had a multi-section barrel on which only the worn part nearest the chamber needed to be changed after prolonged firing. Then came the **8.8-cm Flak 37**, which was a Flak 36 with a revised system of fire-control data transmission more suited to static use than field use. In practice the three models were interchangeable to a high degree, and it was not unusual to see a Flak 18 barrel on a Flak 37 carriage. Several changes were introduced to the weapons once they were in service, including a revised twin-axle carriage arrangement, and the 8.8-cm Flak series was adapted to be carried on a variety of self-propelled mountings, including railway flatcars.

The 8.8-cm Flak series became one of the most celebrated weapons in the entire German army, for it went on to be as famous as an anti-tank weapon as it was as an anti-aircraft gun: following the gun's 'blooding' in Spain during the Civil War and again in France in 1940, it was discovered that the high muzzle velocity coupled with an efficient and heavy projectile made the weapon ideal as a 'tank killer'. This became very evident during the early North African and later Eastern Front campaigns, but the 8.8-cm Flak series was really too high and bulky for the anti-tank role and had to rely on its range and power rather than concealment in action.

As anti-aircraft guns the 8.8-cm Flak series was the mainstay of the German field armies and of the defence of the Reich under Luftwaffe control. The type was never replaced by later models as had been planned, and in August 1944 there were 10,704 of all three models in service. Production was undertaken at several centres, and a wide range of ammunition was produced for these weapons, including a high proportion of armour-piercing. By the end of the war versions for static emplacement only were being produced, but by then the 8.8-cm Flak series had been used on self-propelled platforms, railway mountings, coastal defence locations, light shipping and in several experimental forms.

The 8.8-cm Flak guns were also used by the Italian army, and for a while in late 1944 the type was even used operationally by the US Army along the German borders when its own supply lines became overextended. Many were used by several armies post-war, and the Yugoslav army uses the 8.8-cm Flak as a coastal gun to this day.

Specification

8.8-cm Flak 18

Calibre: 88 mm (3.465 in)

Weight: travelling 6861 kg (15,126 lb) and firing 5150 kg (11,354 lb)

Dimensions: length overall 7.62 m (25 ft 0 in); width 2.305 m (7 ft 6.75 in); height 2.418 m (7 ft 11.2 in); length of barrel 4.93 m (16 ft 2.1 in); length of rifling 4.124 m (13 ft 6.4 in)

Elevation: +85°/−3°

Traverse: 360°

Maximum ceiling: 8000 m (26,245 ft)

Shell weight: HE 9.24 kg (20.34 lb)

Muzzle velocity: 820 m (2,690 ft) per second

GERMANY

8.8-cm Flak 41

By 1939 it was obvious to the long-term German military planners that the expected increases in aircraft performance then on the way would render the existing 8.8-cm (3.465-in) and 10.5-cm (4.13-in) Flak weapons obsolete, so they initiated the development of a new 8.8-cm (3.465-in) weapon. Rheinmetall was given the contract for this new gun, and the company accordingly attempted to integrate into the design all the various lessons learned from the existing 8.8-cm Flak 18 and Flak 37 series. Thus the new weapon, known initially as the **Gerät 37**, was intended for use not only as an anti-aircraft gun but it also had to be suited for use as an anti-tank weapon and even a field or coastal artillery piece.

The result was that when development of the Gerät 37 was completed in 1941 a highly complicated weapon was presented to the troops. The Gerät 37 was adopted as the **8.8-cm Flak 41**, but service development took until 1943 for the design was full of 'bugs', some of which were never entirely eliminated. An example of this can be quoted as the ammunition, which in typical German style used a long and expensive cartridge case. These cases frequently jammed on extraction after firing, to the extent that special high-grade brass cases had to be manufactured specifically for some of the early examples. Both three- and four-section barrels were produced, and the weapon even had an automatic fuse setter on the loading mechanism. There were no fewer than three separate firing circuits, and a powered rammer was fitted.

The first production examples were sent to Tunisia during the latter stages of the North African campaign: here their technical troubles continued and they were given little chance to shine. Thereafter they were assigned to use within the borders of the Reich only, where they could be near the very necessary workshop facilities that they constantly demanded. But it should not be thought that the Flak 41 was an unsuccessful weapon, for when it worked it was an excellent anti-aircraft gun. After the war it was generally regarded as the best of all the German anti-aircraft guns from a technical point of view, but one that required an inordinate amount of maintenance and repair time. When it did work properly it had a rate of fire of up to 25 rounds per minute and had a maximum effective ceiling of 14700 m (48,230 ft). It fired a different round from the other 8.8-cm (3.465-in) weapons.

Despite the technical promise of the Flak 41, the type was never produced in anything but limited numbers. It consumed a great deal of manufacturing potential and production was not assisted by the constant attention given by the Allied air forces to the weapon's main production centre at Düsseldorf. Further lengthy production delays were imposed when an attempt was made to switch some production to the Skoda Werke at Pilsen, but for all their efforts the most the Germans could ever field was 318 and that was in January 1945.

Specification

8.8-cm Flak 41

Calibre: 88 mm (3.465 in)

Weight: travelling 11240 kg (24,780 lb) and firing 7840 kg (17,284 lb)

Dimensions: length overall 9.658 m (31 ft 8.2 in); width 2.4 m (7 ft 10.5 in); height 2.36 m (7 ft 8.9 in); length of barrel 6.548 m (21 ft 5.8 in); length of rifling 5.411 m (17 ft 9 in)

Elevation: +90°/−3°

Traverse: 360°

Maximum effective ceiling: 14700 m (48,230 ft)

Shell weight: HE 9.4 kg (20.7 lb)

Muzzle velocity: 1000 m (3,280 ft) per second

The '88' in Action

The most famous of all anti-aircraft weapons in World War II was the legendary German '88'. That fame rests almost entirely on the fact that the Germans were the first to realize that the high-velocity, flat trajectory shell could be effective against all manner of fortified and armoured ground targets.

The German 88-mm (3.465-in) guns were not intended as anti-armour weapons, now their most famous role. When they were first conceived during the late 1920s and mid-1930s, they were intended to be anti-aircraft guns only and were designed accordingly. Their origins have now passed into a form of legend, for they were designed not in Germany but in Sweden. The large Krupp concern had sent a team there during the 1920s in an attempt to get around the restrictions of the 1919 Treaty of Versailles, which laid down the limitations of what the German armaments industry could design and produce. The team from Essen joined forces with the Bofors concern at Karlskroga and there quietly worked on the finalization of designs for the next generation of German weapons.

An anti-aircraft gun was high on the list of priorities and the design work was secretly funded by the German army back in Berlin. By 1930 the team had produced a 75-mm (2.95-in) gun that met the army's requirements, but as early as that date it was realized that something more powerful would be required for the future, so the Krupp team once more set to, enlarging the 75-mm (2.95-in) design to 88-mm (3.465-in) calibre, and the 8.8-cm Flak 18 was born.

By that time the treaty restrictions were being ignored or were no longer in force, so production of the new gun began in Germany in 1932. The NSDAP under Hitler was well on its way to power, and formed an administration in the following year. Then the programme of expansion of German military power that marked the mid-1930s began in earnest and the 88 was well to the fore in the equipping of the new German armed forces.

The 88s were issued to all arms of the German forces. The Luftwaffe used the 88 for the home defence of the Reich, the German navy for the defence of naval facilities and coastal defence batteries, and the army for use in the field. Each army division had at least one company of 88s (and sometimes more), but in these early stages of rearmament the 88 was meant as an anti-aircraft weapon only.

It was during the Spanish Civil War that the 88 was first put into use as an anti-armour weapon. The exact place and date have not been recorded, but it seems safe to assume that at a critical stage of a Republican armoured breakthrough an enterprising officer took control of an 88 that happened to be located handily nearby and opened fire on the attacking tanks. The results must have been devastating. The light tanks of that period had thin armour proof only against steel shell fragments and little else, so the effect of a high velocity 88-mm (3.465-in) projectile must have been dreadful. The 88 had the long barrel that was needed to propel an anti-aircraft projectile to its operational altitude in a short a time as possible, and the projectile was accordingly propelled by a powerful charge at a high muzzle velocity. Even with a straightforward HE shell the 88 could quite simply punch its way through any contemporary tank and the results of the initial Spanish engagement were duly noted in higher command circles.

By 1939 the 88s were pouring off the production lines. Krupp of Essen produced the bulk of them, but new production centres had by then opened up elsewhere. Enough had been produced for the 88 to be issued at a rate of one eight-gun battalion to nearly every Panzer, mechanized and infantry division. With these formations the guns were towed by the 8-ton Zugkraftwagen SdKfz 7 half-tracked tractor, which also carried the gun crew and some ammunition; more ammunition was carried on

A Flak 18 is manhandled across a pontoon bridge during the May 1940 campaign in France. The river may be the Meuse, as 88s were used there not only to make the crossing possible but also to break up isolated French tank attacks once a bridgehead was established. About eight guns were involved in this operation.

The '88' in Action

Some German 88s were handed over to the Italian army in North Africa and were known then as the Cannone Antiaero da 88/56 modello 36. These examples are in action in North Africa and are firing from their cruciform platforms at aircraft targets; the wheel bogies are retained nearby for a possible rapid withdrawal.

other half-tracks or on trucks. The basic gun crew in the field was six men, but more were usually added for ammunition handling.

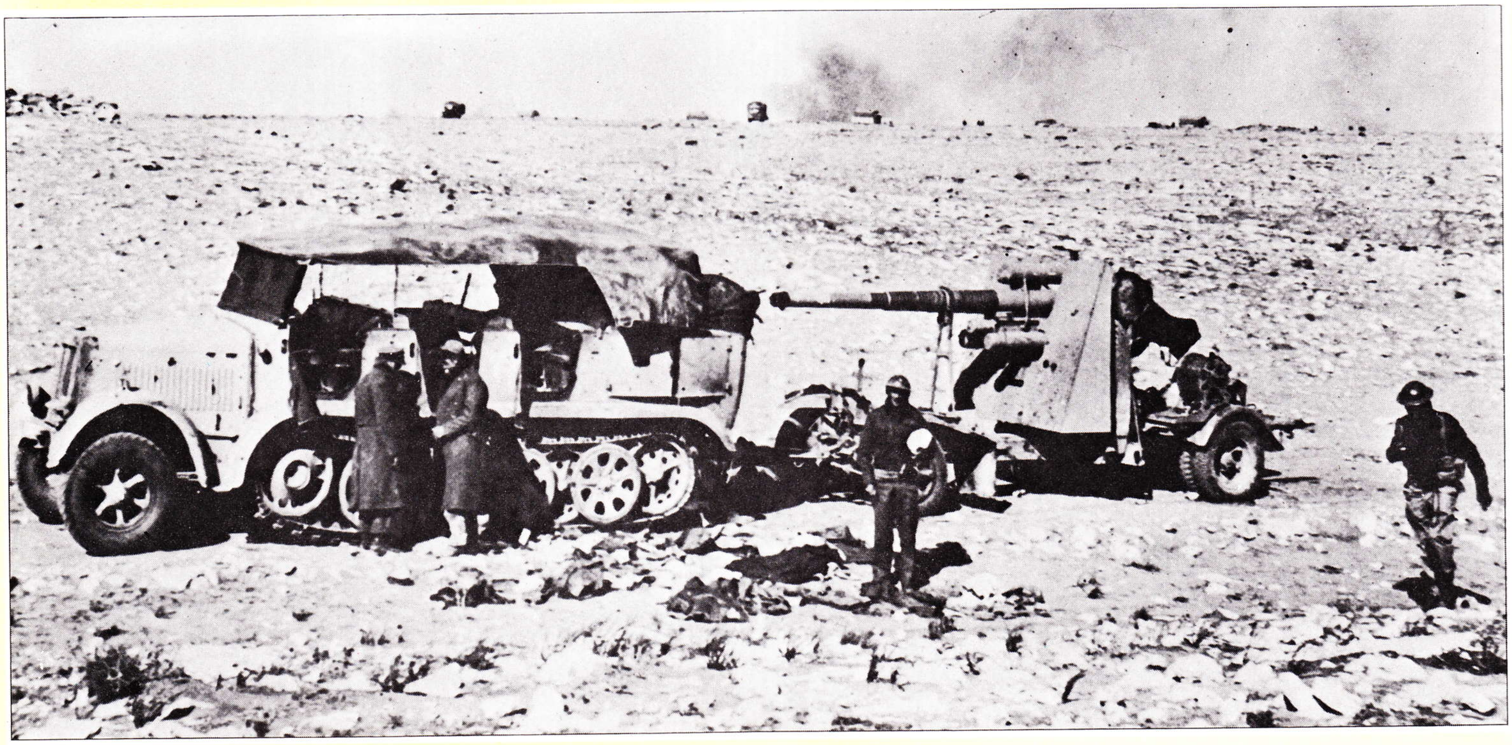
When the 88 was deployed as an anti-aircraft gun, information was relayed from a central fire-control point. On the gun the layers could encounter two types of fire-control apparatus. On the 8.8-cm Flak 18 and the slightly later 8.8-cm Flak 36 the layer was faced by a dial with a series of lamps around the circumference; as the lamps came on he moved a control wheel to align another series of lamps with those on the outer ring. As he moved the control wheel the gun moved in either elevation or traverse. On the 8.8-cm Flak 37 two series of pointers were used: the central fire-control post data relay moved one pointer and the layer the other until the two coincided. These were not the only instruments controlled by the central fire-control post, for there was also a fuse setting machine carried on the gun carriage. Before each shell was loaded the nose fuse was inserted into the machine and once released the shell was immediately loaded and fired. This had the advantage of considerably reducing the 'dead time' between fuse setting and firing and thus increasing accuracy. Later the logical step of mounting the fuse setter next to the loading tray was taken and the 'dead time' was reduced still further. Generally speaking the Flak 37 was used mainly on fixed sites for technical reasons but some were used in the field.

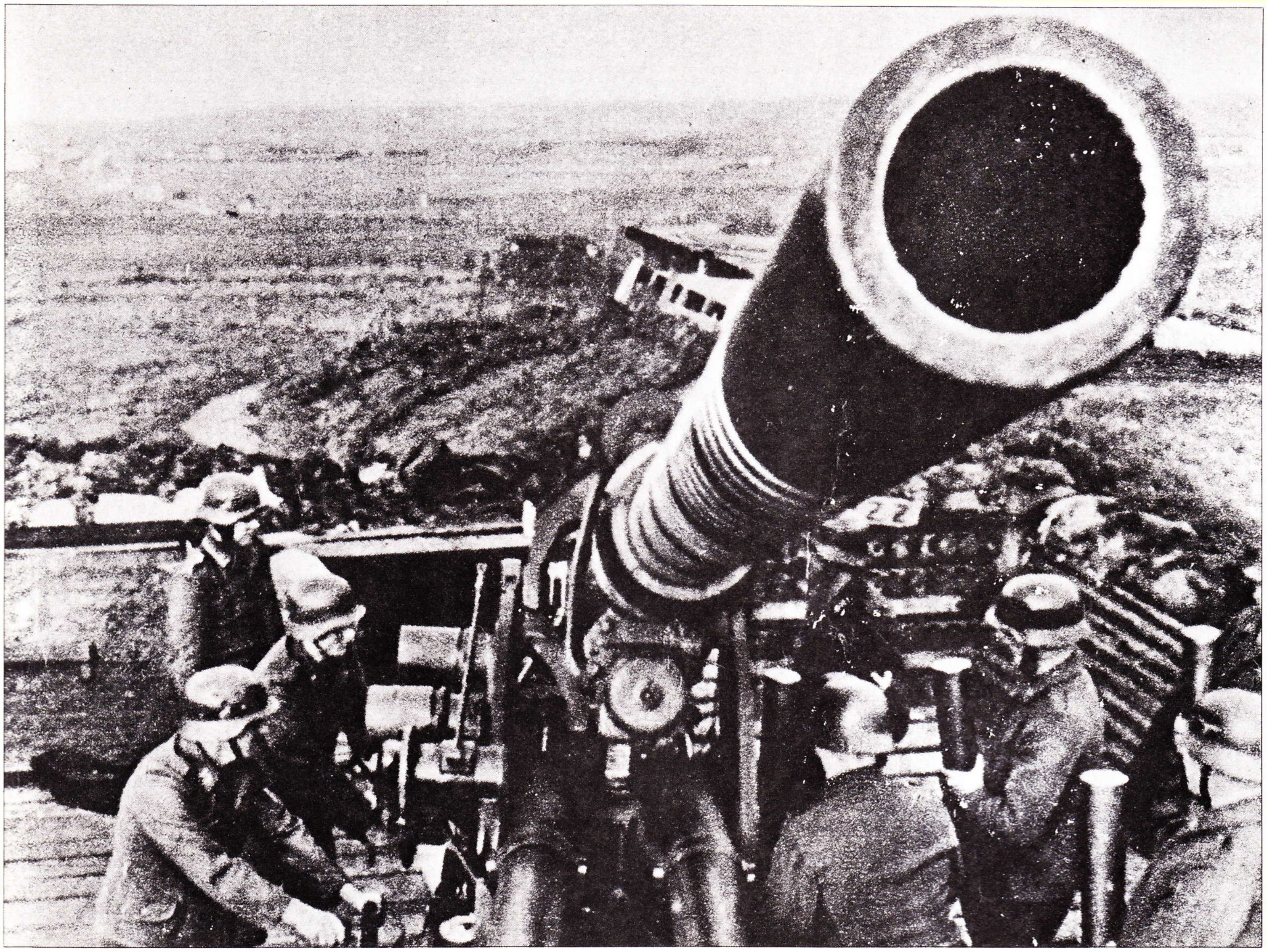
'88' in Poland

In 1939 the use of the 88 as an anti-armour weapon began in earnest, and this was noted by the Western nations at the time. The unfortunate Poles had few modern tanks and what they had were quite simply blown away by the 88s as soon as they arrived on the battlefield. These Polish vehicles had little chance against the 88, for by then the guns had been issued with a new solid anti-tank armour-piercing projectile. Combined with the power of the 88 this shot could penetrate the thickest armour then in use. When used in the anti-armour role the 88s were often fitted with a frontal shield to provide some protection for the crew, for in the field the 88 was a high and bulky target for the enemy. The barrel was carried on a high pedestal mount in order to provide the gun with 360° traverse for anti-aircraft use, and this made the centre of gravity of the gun rather high. The 88 was also a weighty weapon to use on a battlefield and the large half-tracked tractor was very necessary to get the gun in and out of action.

The normal method of bringing the gun into action was to use the tractor to race to the desired emplacement point, where the tow bar was disconnected to allow the departure of the half-track after dropping off the crew and some ammunition. The crew then had the heavy job of using the winches and pulleys on the gun's twin-axle carriage to remove the axles and lower the gun to the ground. The outriggers were then lowered, the gun was levelled and all was ready for action. On the early versions of the twin-axle carriage the gun was arranged so that the barrel would point forwards towards the tractor. After experience in Poland and France this was altered so that the barrel would point to the rear, i.e. towards the enemy as the tractor re-engaged the load. This enabled the gun to remain in action until the last possible moment in the case of a hurried withdrawal. There was a fixture for a telescopic sight by the aimer's position and for long-range artillery use there was a fitting for an artillery dial sight on top of the recuperator cylinder over the gun. When engaging ground targets range information came from a hand-held rangefinder.

A captured Flak 18 is seen with the early Sonderhanger 201 wheeled carriage; the later Sonderhanger 202 had the barrel pointing to the rear. The tractor is a half-tracked Sd Kfz 7, the vehicle used whenever possible to tow the 88. The tractor also carried the crew and some ammunition, and all their gear.





A German 8.8-cm Flak 18 in a typical emplacement and ready for action. The men on the right are holding rounds with their shells downwards, ready to place their nose fuses directly into the fuse-setting machine – the layers on the left are watching their data transmission dials.

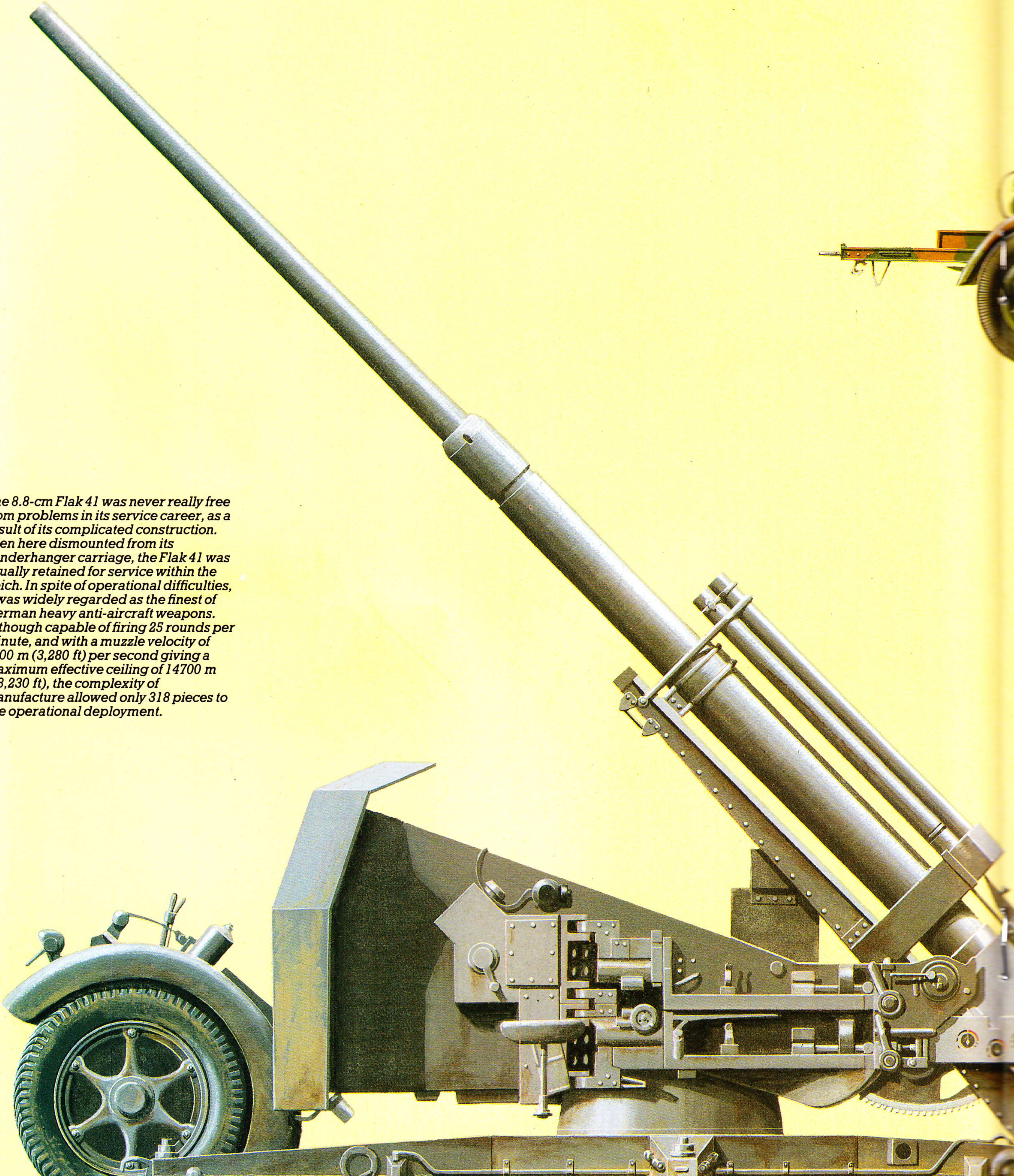
The 88 really made its mark on the Western Allies during the May 1940 campaign in France, and especially during the crossing of the Meuse at Dinant on 13 May. There the river crossing by the assault boats of the leading forces was held up by well-emplaced bunkers and some armour on the opposite bank. By bringing up a battery of four 88s the Germans were able to knock out every one of the opposing strong points one by one until the crossing could go ahead unopposed. Later in the same campaign it was noted that the 88 was the only German weapon that could penetrate the heavy frontal armour of the British 'Matilda' infantry support tanks.

Despite these successes the 88 had yet to show one of its major attributes, namely its range. It was rare on the battlefields of France for actions to take place at more than about 1000 m (1,095 yards), but the 88 was capable of knocking out tanks at twice that range. This was to be repeatedly demonstrated on the wide expanses of the North African deserts and the vast plains of the Soviet Union, where time and again the 88s were able to engage and knock out enemy tanks at ranges greater than those of the tanks' main armament. This was particularly true in North Africa, where at first the British tanks were armed with only a 2-pdr gun with a limited effective range. The 88s could knock out such tanks at ranges twice the effective reach of such tank guns, so the destruction of tanks at ranges of 2000 m (2,185 yards) in the desert was a not uncommon occurrence. The British 'tankies' did not help themselves, for on many occasions they were apt to indulge in what can only be described as cavalry charges against well-defended German positions. One of these fatal charges was against a position known as Hill 208 in early June 1941. The Germans had used their time to good effect on that hill, for they had dug in 13 88s in such a way that only their barrels could be seen above ground. They were able to pick off the advancing British cruiser tanks with ease until the ground in front of Hill 208 was littered with hulks. Thus the Battle of Sollum ended with yet another British retreat.

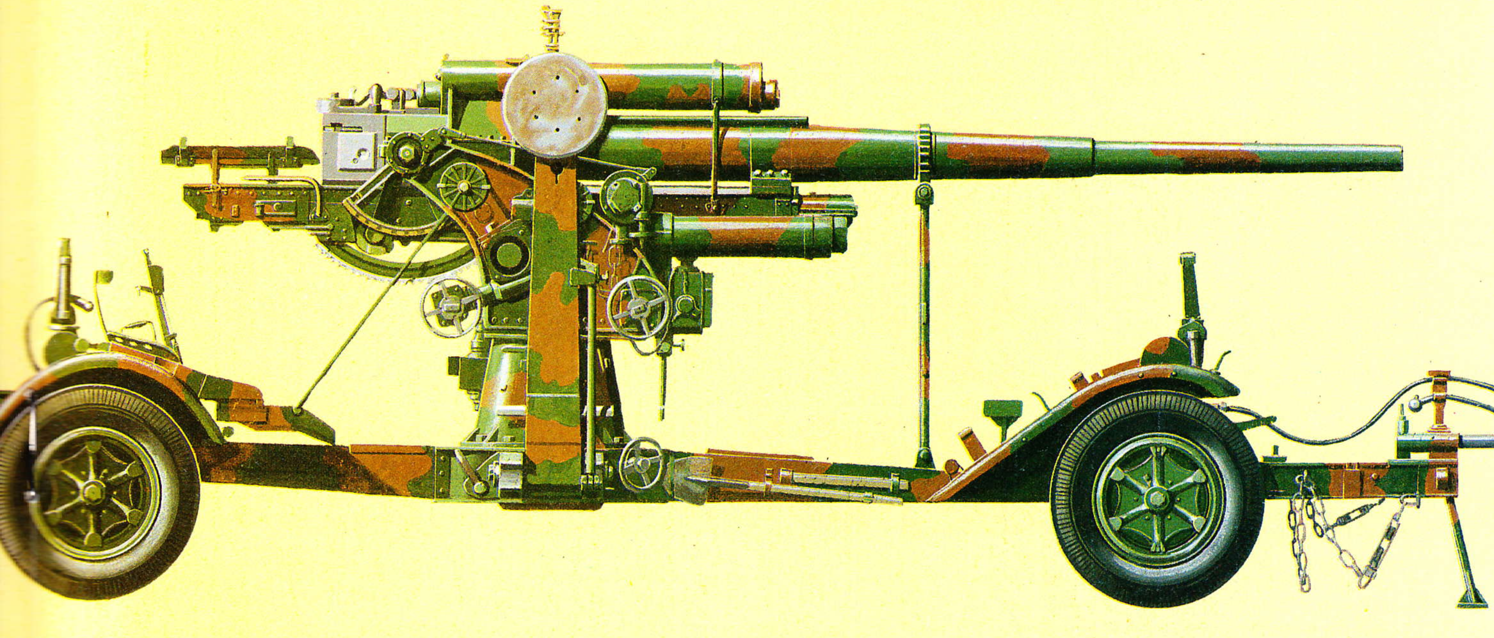
Prime target

It should not be thought that the 88s always had things their own way. As has already been mentioned, the 88s were high and bulky weapons that stood out against the flat terrain of North Africa and the Soviet Union. Both the Allies and the Red Army came to recognize the bulk of the 88 and treat it with respect. When possible they engaged the 88s with field artillery fire, and when subjected to such fire the 88 was often lost, usually by its crew being disabled where they stood. It was possible to conceal the guns by the usual process of digging in, but this took time and in the mobile and fluid warfare of the desert and steppe time was not always available. Getting the 88 in and out of action could not be carried out quickly unless the gun crew was either well trained or very strong, and both these assets were sometimes lacking. The 88 only became the anti-armour par excellence when it was adapted to a proper anti-tank gun carriage.

But even while still in the original Flak form the 88 could often turn the result of a battle right until the end of the war. A typical example of this occurred on the Bourgebus Ridge during the fighting in Normandy in July 1944. As part of Operation 'Goodwood' two British armoured divisions, the 11th and the 7th, were advancing up over the ridge through a maze of small localities defended by the Germans. The stubborn defence of these localities had already severely upset the British timetable when onto the scene came a Panzergrenadier colonel by



The 8.8-cm Flak 41 was never really free from problems in its service career, as a result of its complicated construction. Seen here dismounted from its Sonderhanger carriage, the Flak 41 was usually retained for service within the Reich. In spite of operational difficulties, it was widely regarded as the finest of German heavy anti-aircraft weapons. Although capable of firing 25 rounds per minute, and with a muzzle velocity of 1000 m (3,280 ft) per second giving a maximum effective ceiling of 14700 m (48,230 ft), the complexity of manufacture allowed only 318 pieces to see operational deployment.

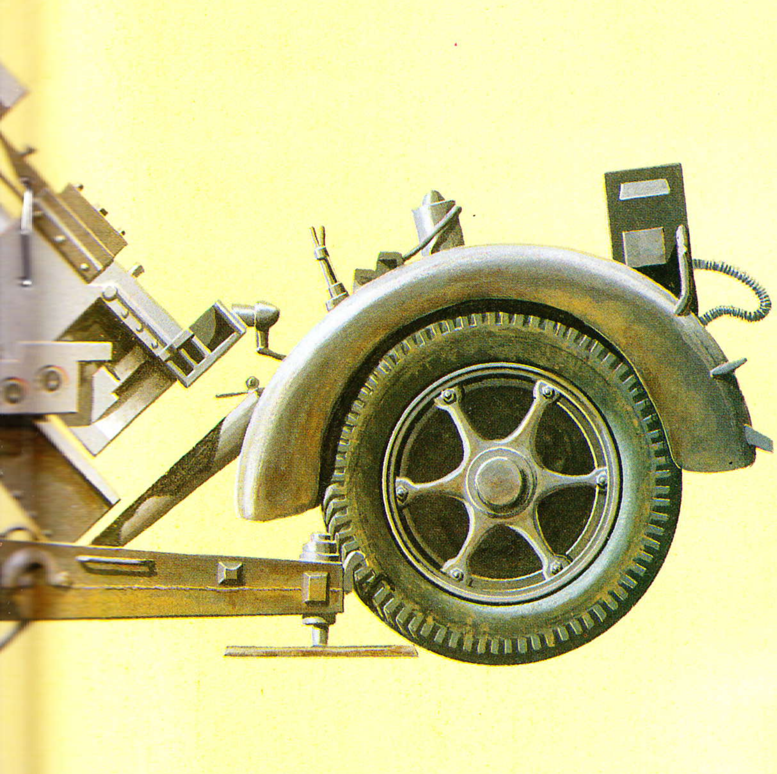


Designed by a Krupp team in Sweden (in order to circumvent the conditions of the Treaty of Versailles), the 8.8-cm Flak 18 entered production in 1933, and with the National Socialist state was to become legendary. Originally made with a one-piece barrel, later models were equipped with multi-sectioned barrels to allow replacement of worn sections. Seen here on the Sonderhanger 201 carriage (the later model 202 travelled with the barrel to the rear), the Flak 18 was usually towed by the eight-tonne Sdkfz 7 half-track.

the name of von Luck. He was fresh from a few days' leave in Paris, but once on the scene showed a remarkable talent for summing up the tactical scene. He noted a force of about 60 British tanks moving across the Bourgebus Ridge to his front and he also noticed four Luftwaffe 88s, an 88-mm (3.465-in) anti-tank gun and a Tiger tank in the streets of nearby Cagny: if these could be moved to the north east corner of Cagny, von Luck realized, they would be able to take the advancing British tanks in the flank. The Luftwaffe officer in charge of the 88s was unwilling to make the move until his mind was changed by the muzzle of von Luck's pistol, and in a very short time the five 88s were in action along with the Tiger. Within minutes 16 British tanks had been immobilized and in the resultant confusion the British armoured column grew into one gigantic traffic jam. Tanks milled about and blocked further progress to the point where the British advance stalled with the five 88s still pouring shells into them. By the time things had been sorted out the following armoured formations had joined in the jam, but by that time the Germans had been able to pour yet more defending troops and weapons into the fight and Operation 'Goodwood' came to an abrupt end. The Bourgebus Ridge was not taken that day, as a result mainly of the 88s and von Luck's timely intervention.

The Bourgebus Ridge scrap was typical of many in which the 88 was involved, but away from the anti-armour scene the Luftwaffe 88s used for the defence of the Reich remained in action right up to the end. Most home defence 88s retained their mobile carriages but were usually statically emplaced in prepared positions with all the usual paraphernalia of protected shelters, ammunition magazines and complicated communication networks. Many batteries operated under radar control as the war progressed, and several types of ammunition were introduced to boost performance. Even before the war started there were several proposals to supplement or replace the early 88s. The 8.8-cm Flak 41 proved to be an excellent gun but it was difficult to produce, prone to all manner of technical troubles and so was produced in small numbers only. The 10.5-cm (4.13-in) Flak guns proved to be too bulky for the field army and the massive 12.8-cm Flak 40s were reserved for home defence in small numbers only. So the 88s had to bear the brunt of the Allied aerial onslaught that came by night and day from 1941 onwards.

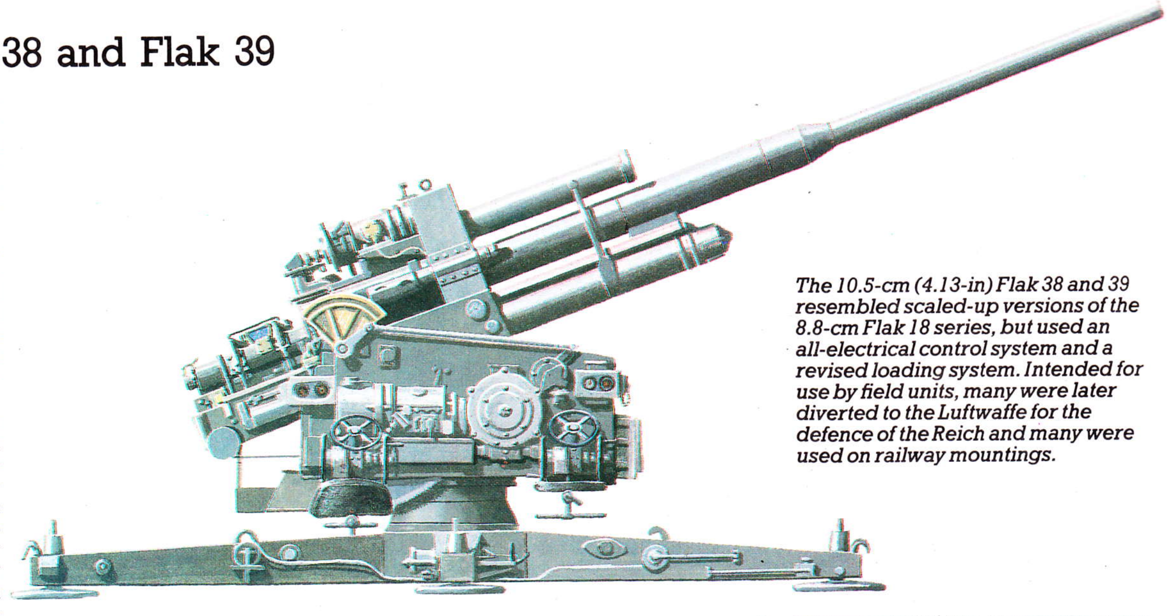
The Allied bombardments tended to concentrate on one target at a time, returning night and day until the target was flattened. Hamburg was a typical example of this, the city being destroyed as the local defences were overwhelmed. In order to concentrate some form of mobile reserve the Luftwaffe took to mounting 88s on railway flatcars, the resultant trains being towed around the Reich wherever they might be needed. By the time the war ended there were many such trains on which the guns and their crews remained for weeks at a time. Once near a likely or actual target they were deployed in marshalling yards and along convenient stretches of track along with their ammunition trucks and centralized fire-control equipments. In the Soviet Union single 88s were sometimes added to ordinary trains for protection against air attack or partisan activities.



GERMANY

10.5-cm Flak 38 and Flak 39

As far back as 1933 the German military planners saw a need for an anti-aircraft gun heavier than the 8.8-cm (3.465-in) Flak series, and both Rheinmetall and Krupp were invited to submit designs for a 'shoot-off' contest for 10.5-cm (4.13-in) weapons held in 1935. Rheinmetall won the contract with its **Gerät 38**, which duly went into production as the **10.5-cm Flak 38**. This model had an electrical control system and a powered loading mechanism, but was soon replaced in production by the **10.5-cm Flak 39** with a revised electrical and fire-control data system.



The 10.5-cm (4.13-in) Flak 38 and 39 resembled scaled-up versions of the 8.8-cm Flak 18 series, but used an all-electrical control system and a revised loading system. Intended for use by field units, many were later diverted to the Luftwaffe for the defence of the Reich and many were used on railway mountings.

Both 10.5-cm (4.13-in) Flak guns were intended for use by the German field armies, but in the event they were almost all employed in the home defence of the Reich. In appearance the Flak 38 and Flak 39 resembled scaled-up Flak 18 guns, but there were many detail differences and proportionally the Flak 38 and Flak 39 were much heavier and bulkier weapons. In overall terms the Flak 38 and Flak 39 were complex weapons and were made more complex to manufacture by the use of a sectional barrel (for rapid change of the worn portion only after firing) on the Flak 39. Unfortunately, in action they proved to be little better than the 8.8-cm (3.465-in) Flak series as far as overall performance was concerned, and at one point it was even intended to replace them in production by the 8.8-cm (3.465-in) Flak 41 though this never happened: production of the Flak 41 was so slow that the 10.5-cm (4.13-in) Flak guns were kept on the production lines. When the war ended there were still 1,850 in service, most of these within the borders of the Reich.

Although intended as a field weapon, the Flak 38 and Flak 39 were really too heavy for the role. They used a scaled-up version of the mobile twin-axle carriage of the 8.8-cm (3.465-in) Flak series, but even with the aid of integral winches and pulleys the guns were slow and awkward to emplace. Many were subsequently assigned to static emplacements, and 116 were mounted on special Flak railway trucks that rumbled around the Reich wherever they were needed. Each model needed a crew of a commander and nine men, though use of the manual loading system required a further two men.

The 10.5-cm (4.13-in) Flak series never acquired the fame of the 8.8-cm (3.465-in) Flak series, mainly because it was not widely used in the field and because its bulk and weight meant that it was only rarely used as an anti-armour weapon. Overall its performance was not as good as had been originally hoped, and despite a great deal of development work on a project known as the **10.5-cm Flak 40**, which was to have had a longer barrel to fire a heavier projectile, the 10.5-cm (4.13-in) Flak guns were never 'stretched' to the same extent as the other German Flak guns. Instead production went steadily ahead at several centres until the war ended.

Specification

10.5-cm Flak 39

Calibre: 105 mm (4.13 in)

Weight: travelling 14600 kg (32,187 lb) and firing 10240 kg (22,575 lb)

Dimensions: length overall 10.31 m (33 ft 9.9 in); width 2.45 m (8 ft 0.5 in); height 2.9 m (9 ft 6 in); length of barrel 6.648 m (21 ft 9.7 in); length of rifling 5.531 m (18 ft 1.9 in)

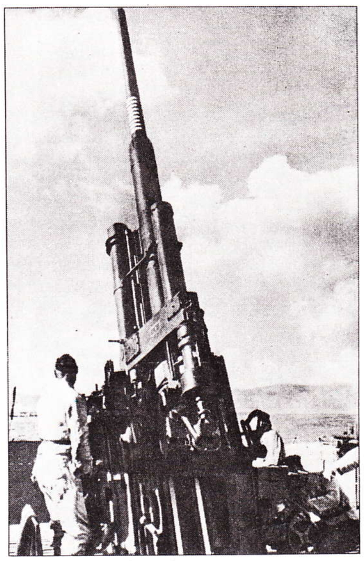
Elevation: +85°/−3°

Traverse: 360°

Maximum ceiling: 12800 m (41,995 ft)

Shell weight: 15.1 kg (33.3 lb)

Muzzle velocity: 880 m (2,887 ft) per second



A 10.5-cm Flak 39 in action on a special railway truck mounting, here being used for harbour defence. These railway mountings were moved around the occupied territories and the Reich itself.

GERMANY

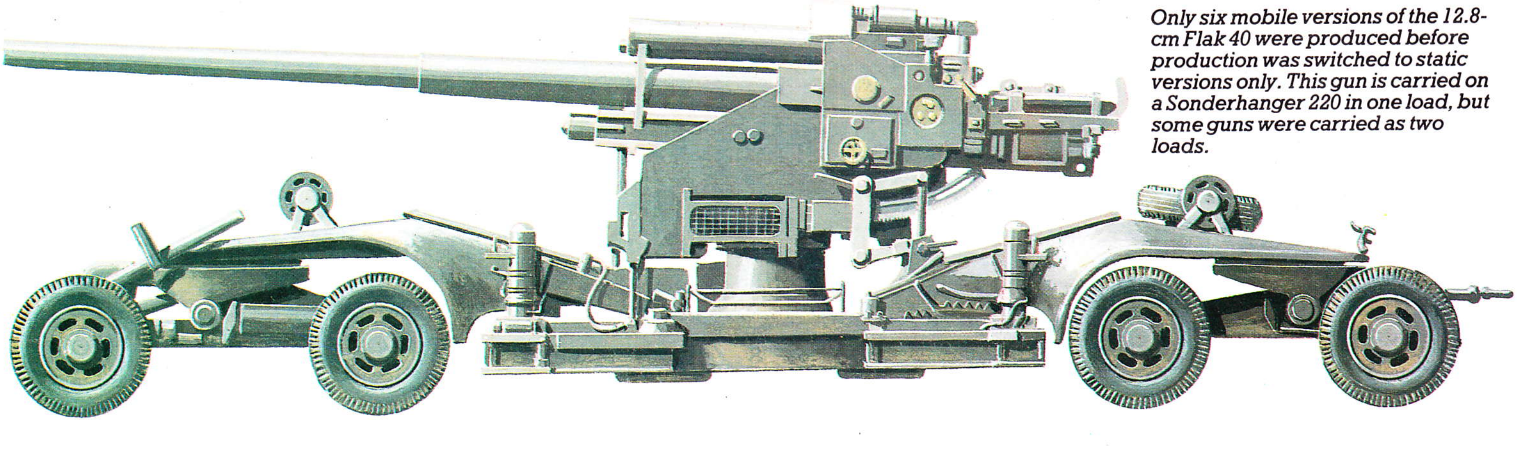
12.8-cm Flak 40

The idea of producing a German 128-mm (5.04-in) anti-aircraft gun was first mooted in 1936 when Rheinmetall was requested to produce a design known then as the **Gerät 40**. Progress on this design was not placed at a very high priority, so it was not until 1940 that the first prototype was ready. At that time it was intended that the Gerät 40 would be a weapon for the field army, but when the military saw the size and bulk of the prototype they decided that the weapon would be produced for static use only. The weapon was ordered into production as the **12.8-cm Flak 40**.

By that time plans had already been made for a production-line mobile version, so the first six were produced on mobile carriages. The Flak 40 was so large that it proved impossible to carry the gun in one load over other than very short distances, so a two-load system was initially employed. Even this proved to be too cumbersome, and was later revised to a single load once again. Later versions were produced for static use only, and such was the overall performance of the Flak 40 that it was carefully emplaced around some of the main production and population centres such as Berlin and Vienna. Special Flak towers were built in some locations to make best use of these guns, and there was also a special railcar version to provide the guns with some sort of mobility.

Production of the static version began in 1942, but it was a costly and complex gun so by January 1945 there were only 570 in service, all of them based inside the borders of the Reich.

Soon after full-scale production began, the Flak 40 was joined by a twin version of the same gun known as the

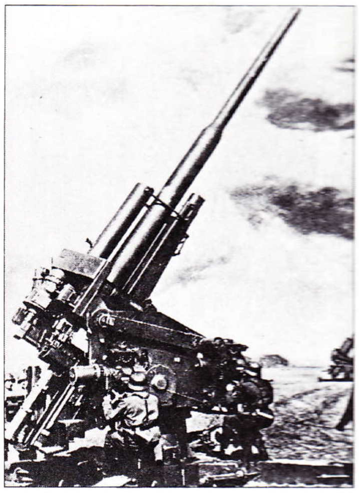


Only six mobile versions of the 12.8-cm Flak 40 were produced before production was switched to static versions only. This gun is carried on a Sonderhanger 220 in one load, but some guns were carried as two loads.

12.8-cm Flakzwilling 40. This consisted of two 12.8-cm (5.04-in) Flak guns mounted side-by-side on the same mounting and provided with 'mirror' loading arrangements. These powerful gun combinations were used only on special Flak towers around the main centres of population within the Reich, and were so costly and difficult to produce that there were never many of them; even by February 1945 there were only 33 in service. The Flakzwilling (*Zwilling*, or twin) was introduced as it was realized that ever heavier anti-aircraft guns would be needed to counter the increasing performance of Allied bombers, and despite strenuous efforts to develop guns with calibres of 150 mm (5.9 in) and even 240 mm (9.45 in), none got past the prototype stage at best and some failed to get even that far. Thus the twin arrangement of the Flakzwilling 40 was an attempt to produce at least some form of increased firepower to counter the Allied heavy bombers, and in the event it turned out to be an excellent anti-aircraft weapon.

As the war ended the original mobile Flak 40s were still in use, many more were in use on special Flak trains. A new **12.8-cm Flak 45** gun was under development as the war ended, and this would have been an even more powerful weapon than the original. Only a single prototype was completed.

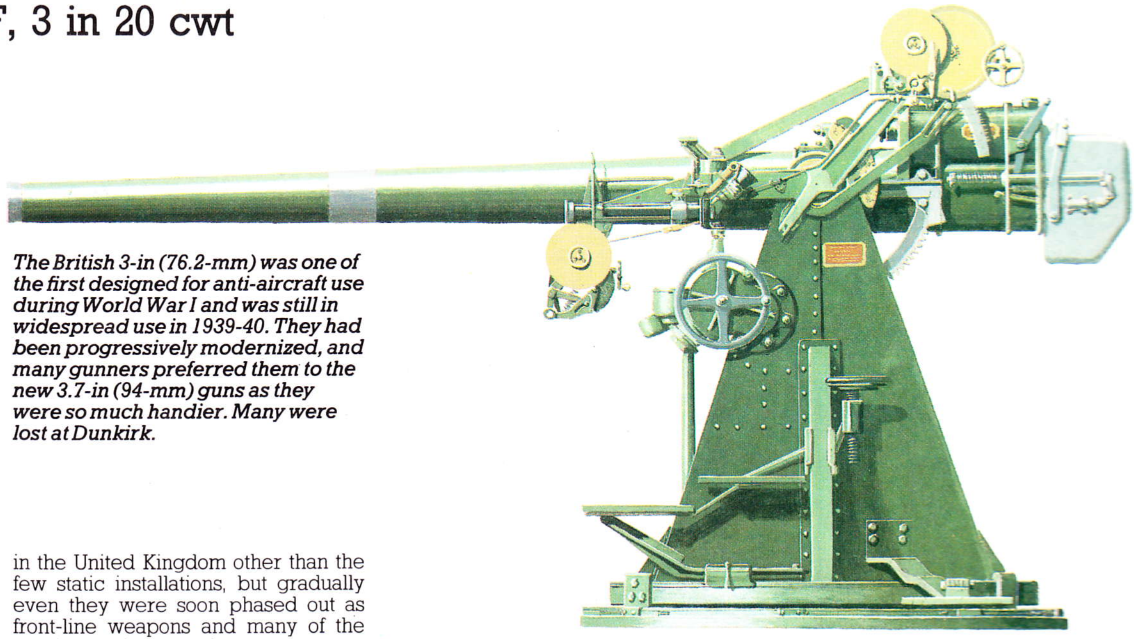
Specification
12.8-cm Flak 40
Calibre: 128 mm (5.04 in)
Weight: travelling (mobile) 27000 kg (59,524 kg), firing (mobile) 17000 kg (37,478 lb), and firing (static) 13000 kg (28,660 lb)
Dimensions: length overall 15 m (49 ft 2.6 in); height 3.965 m (13 ft); length of barrel 7.835 m (25 ft 8.5 in); length of rifling 6.478 m (21 ft 3 in)
Elevation: +87°/−3°
Traverse: 360°
Maximum effective ceiling: 14800 m (48,555 ft)
Shell weight: 26 kg (57.3 lb)
Muzzle velocity: 880 m (2,887 ft) per second



This photograph of 12.8-cm Flak 40s in the field was taken in 1940 in order to show the 'might' of the German army's anti-aircraft field defences. In fact only one battery was so used before all production of the gun was switched to the home defence of the Reich. This one battery was also moved out of the field.

UK

Ordnance, QF, 3 in 20 cwt



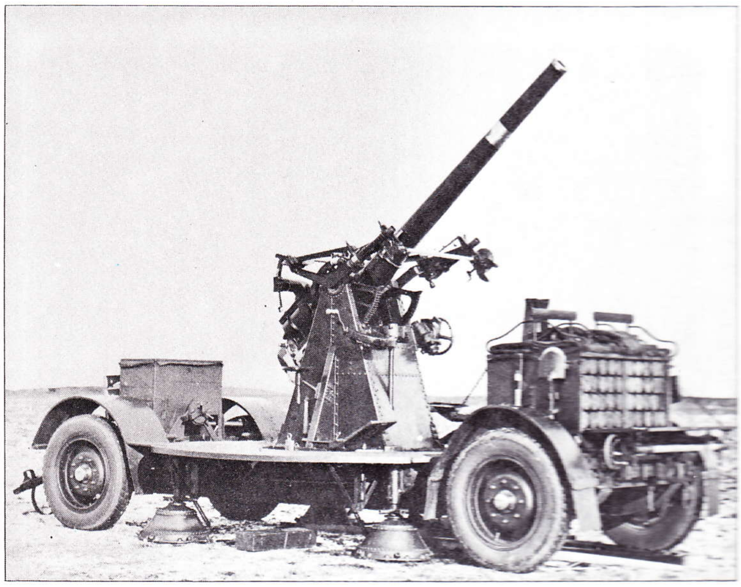
The British 3-in (76.2-mm) was one of the first designed for anti-aircraft use during World War I and was still in widespread use in 1939-40. They had been progressively modernized, and many gunners preferred them to the new 3.7-in (94-mm) guns as they were so much handier. Many were lost at Dunkirk.

The British 76.2-mm (3-in) anti-aircraft gun had the distinction of being one of the very first, if not the first gun to be designed specifically for the anti-aircraft role, the initial examples being in service as early as 1914. From that time the basic design was gradually modified and generally updated, and in 1940 there were still many in service as the **Ordnance, QF, 3 in 20 cwt**. The updating meant that the gun was still a viable weapon for its role, but its overall performance was such that it lacked the power of later designs and it was intended in 1939 that most of them would be replaced by more modern equipments (mainly the 94-mm/3.7-in weapon) by 1941.

In 1939 there were no fewer than eight marks of gun in service, some with sliding breech blocks, some with interrupted thread blocks, some with loose barrel liners, and so on. There was an equally formidable array of carriages in use as well: some of these had four wheels, others had but two and still more were statically emplaced in concrete. By 1940 nearly all in-service anti-aircraft (ack-ack) gunners had been trained on the 76.2-mm (3-in) gun for not only was it the standard weapon of the small regular forces but it was also the main equipment of the growing number of Territorial Army batteries that were formed during the late 1930s.

The gun was of simple design, being little more than a barrel and recuperator/recoil mechanism slung between two side mounting plates carried on a turntable. The turntable could be either mounted on a heavy cruciform firing platform or carried on a four-wheeled platform, the field army preferring the latter by 1939. The gun was the mainstay of the anti-aircraft batteries with the BEF, for although some batteries had been issued with the 94-mm (3.7-in) gun by 1940, they by far preferred the much lighter and handier 76.2-mm (3-in) gun with which they were familiar. However, the Dunkirk episode put paid to that source of dissent for most of the 76.2-mm (3-in) guns with the BEF were either destroyed or captured by the Germans (they later took over the type for their own use by units in France under the designation **7.5-cm Flak Vickers (e)**). There were few servicable 76.2-mm (3-in) guns left in the United Kingdom other than the few static installations, but gradually even they were soon phased out as front-line weapons and many of the mobile platform carriages were converted to rocket-launching platforms. About 100 platforms were eventually converted for this rocket role, and of the barrels removed some were used as the main armament for a tank destroyer using a Churchill tank chassis. That project eventually came to nothing, and mystery still surrounds a project to place 50 old 76.2-mm (3-in) guns onto surplus 17-pounder anti-tank gun carriages for home defence during 1944. There were few, if any, 76.2-mm (3-in) anti-aircraft guns left in service by 1945.

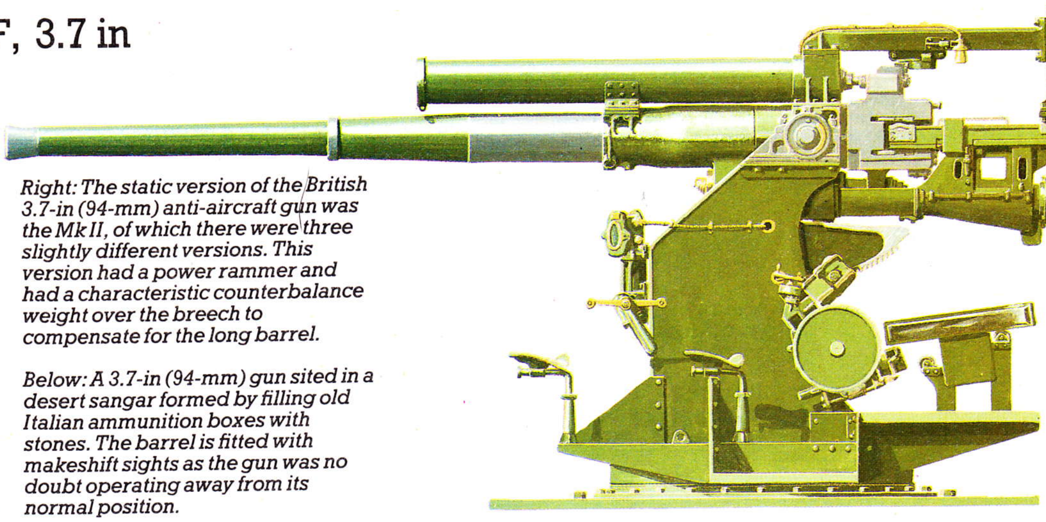
Specification
Ordnance, QF, 3 in 20 cwt (on four-wheel platform)
Calibre: 76.2 mm (3 in)
Weight: travelling and complete 7976 kg (17,584 lb)
Dimensions: length travelling 7.468 m (24 ft 6 in); width travelling 2.311 m (7 ft 7 in); height 2.794 m (9 ft 2 in); length of barrel 3.551 m (11 ft 7.8 in); length of rifling 2.977 m (9 ft 9.2 in)
Elevation: +90°/−10°
Traverse: 360°
Maximum ceiling: 7163 m (23,500 ft)
Shell weight: 7.26 kg (16 lb)
Muzzle velocity: 610 m (2,000 ft) per second



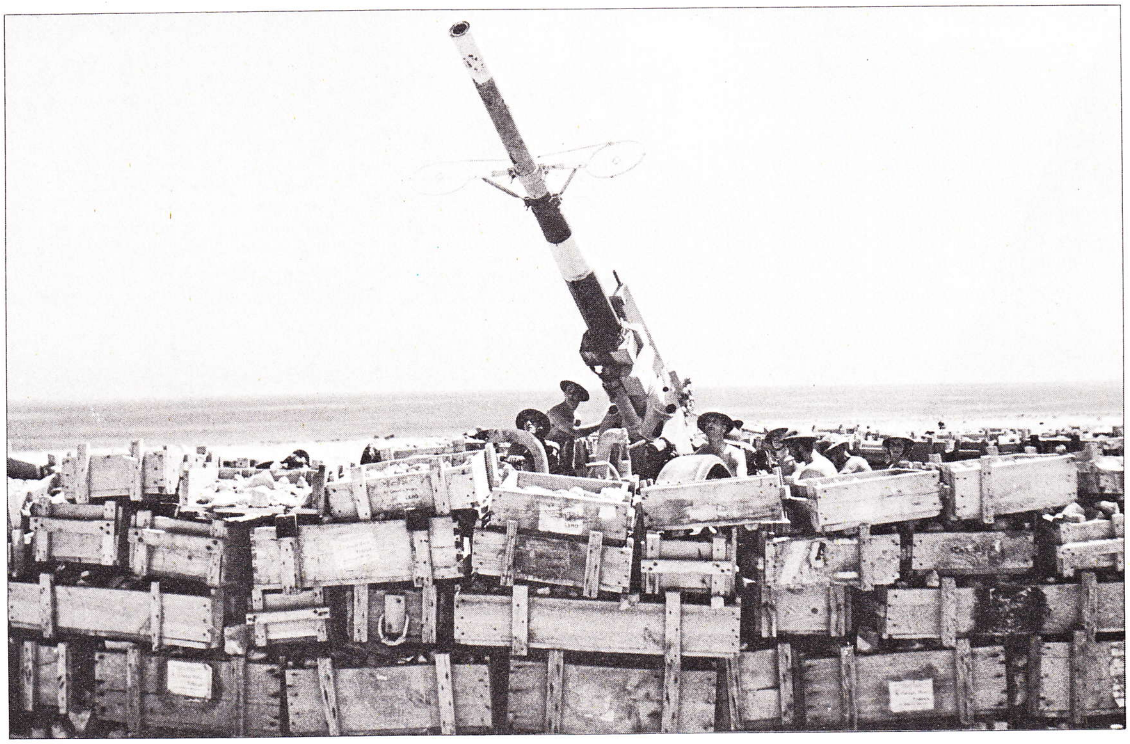
The usual model of the 3-in (76.2-mm) gun in use with the BEF in 1940 was this platform version, complete with twin axles. The platform used outriggers when firing and the feet for these can be seen below the gun platform. The locker housed ready-use ammunition and the sights.

UK

Ordnance, QF, 3.7 in



Right: The static version of the British 3.7-in (94-mm) anti-aircraft gun was the Mk II, of which there were three slightly different versions. This version had a power rammer and had a characteristic counterbalance weight over the breech to compensate for the long barrel.



Below: A 3.7-in (94-mm) gun sited in a desert sangar formed by filling old Italian ammunition boxes with stones. The barrel is fitted with makeshift sights as the gun was no doubt operating away from its normal position.

Soon after World War I ended it was suggested that something heavier and more powerful than the existing 76.2-mm (3-in) anti-aircraft gun would be required by the UK to meet anticipated increases in aircraft performance, but at that time (1920) the report was simply shelved as there was then no prospect of any funding for even initial research into such a project. Instead it was not until 1936 that Vickers produced a prototype of a new gun with a calibre of 94 mm (3.7 in). The design was approved for production as the **Ordnance, QF, 3.7 in**, but initial progress towards this goal was so slow that it was not until 1938 that the pilot production models were issued for development trials.

The main reason for this slow progress was the gun's carriage. While the gun was a fairly straightforward but modern component, the carriage was complex to what seemed an extreme. The gun was intended for use in the field by the army and thus had to be fully mobile, but the final assembly was what can only be classed as 'semi-mobile'. The gun and its cradle and saddle rested on a large firing platform which in action rested on four outriggers. The front wheels were raised off the ground in action in order to provide some counter-balance for the weight of the gun mass, and the rear (towing end) axle was removed. Production of the carriage soon proved to be a time-consuming bottleneck, to the extent that production began of what was to be a purely static carriage for emplacement in concrete. As time went on the carriage was re-engineered to a more manageable form. Thus the first production carriage was the Mk I, the static carriage the Mk II and the final production version the Mk III; there were sub-marks of all of these.

When the equipment was first issued the gunners did not take kindly to it as they by far preferred the handier and familiar 76.2-mm (3-in) gun, but even they came to appreciate that the performance of the 94-mm (3.7-in) ordnance by far exceeded that of the older gun. In fact the 94-mm (3.7-in) had an excellent all-round performance even if emplacing and moving it was sometimes less than easy. As more equipments entered service they were gradually fitted with improved and centralized fire-control systems and such extras as power rammers and fuse setters. By 1941 the type formed the mainstay of the army's anti-aircraft defences, and went on through the rest of the war to prove itself to be an excellent weapon.

The 94-mm (3.7-in) gun was impressed into use as an anti-armour weapon in the Western Desert campaigns, but its weight and bulk made it less than effective in this role although it could still knock out any tank set against it. Instead it was retained for what it was best suited, the anti-aircraft role, and thus the 94-mm (3.7-in) never really got a chance to prove itself as the British equivalent of the German '88'. It was used on occasion as a long-range field piece and was even at one stage of the war used as a coastal defence gun. However, its use in this role was in the hands of the Germans, who had captured some of the type at Dunkirk. They appreciated the effectiveness of the weapon they termed the **9.4-cm Flak Vickers M.39(e)** so much that they even went to the trouble of manufacturing their own ammunition for them for both the Flak and the coastal defence roles. In the latter they were particularly effective at Walcheren, where 94-mm (3.7-in) guns sank several Allied landing craft.

The gun soldiered on in British use until Anti-Aircraft Command was disbanded during the 1950s. Many were sold or handed over to other nations, and some still survive in use in such locations as South Africa and Burma.

Specification

Ordnance, QF, 3.7 in Mk III on Carriage Mk III

Calibre: 94 mm (3.7 in)

Weight: complete 9317 kg (20,541 lb)

Dimensions: length overall travelling 8.687 m (28 ft 6 in); width 2.438 m (8 ft); height 2.502 m (8 ft 2.5 in); length of barrel 4.7 m (15 ft 5 in); length of rifling 3.987 m (13 ft 0.95 in)

Elevation: +80°/−5°

Traverse: 360°

Maximum effective ceiling: 9754 m (32,000 ft)

Shell weight: HE 12.96 kg (28.56 lb)

Muzzle velocity: 792 m (2,600 ft) per second

A victory salute is fired in May 1945 by a complete battery of 12 3.7-in (94-mm) guns, probably on the Larkhill ranges on Salisbury Plain.

These guns were only just entering production when the war began, but they remained in British service until the late 1950s.

Ack-Ack in the Battle of Britain

The long, hot summer of 1940 saw the air defences of Britain straining under the weight of air attacks of unprecedented scale. The parts played by the RAF and by radar were well known, but the contribution made by the thousands of anti-aircraft gun crews labouring long hours under spartan conditions was also important, although less glamorous, and has often been overlooked.

Life on an ack-ack (ack-ack for AA or anti-aircraft) site was never a pleasure in 1940, for the sites were seemingly set in remote areas far from civilization. There were few amenities to hand, and there was at all times the prospect of imminent action with all the dangers it could entail. On one particular site in north Kent it was even less pleasant than usual, for this was situated among the mud flats on the southern edge of the Thames estuary. Not only was the situation bleak and desolate, but it was also miles from the nearest centre of habitation and facilities on the site were basic to an extreme.

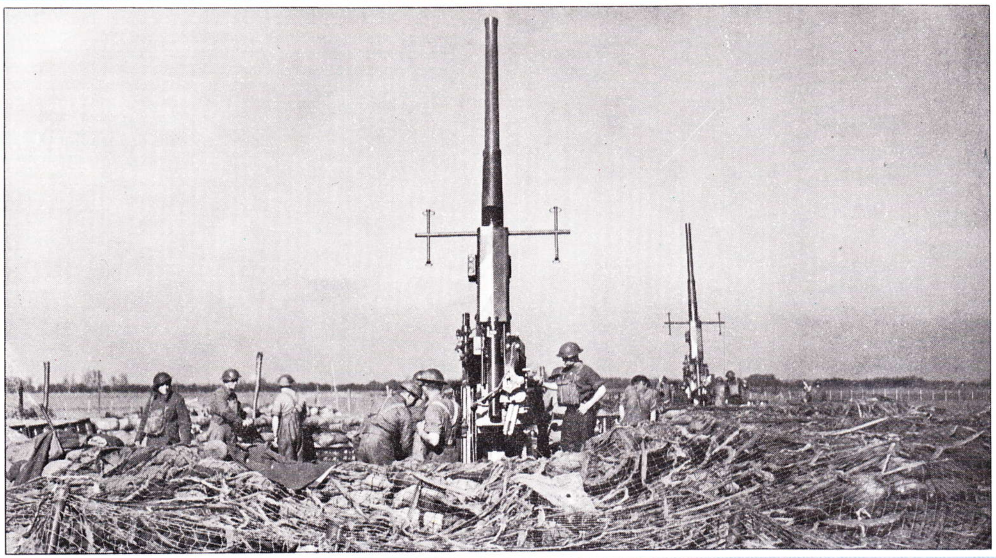
The battery had moved there during the previous winter, which had turned out to be one of the coldest and most severe in living memory. The bulk of the battery personnel were ex-Territorials who had trained for years before 1939 on the old 76-mm (3-in) anti-aircraft gun, a weapon they had come to know and understand intimately. Unfortunately once it had been mobilized the battery's officers and NCOs had been supplemented by a leavening of regular officers and NCOs and their old guns had been taken away. In their place the battery had been given four of the new 94-mm (3.7-in) guns, and these it had taken to the new site on the mud flats.

When the battery arrived there everything was under a sea of mud. The electrical supply was prone to breakdown, so the men usually had to rely upon their own battery generators for lighting, and fuel was scarce for the stoves that signally failed to warm the stark interiors of the Nissen huts in which the gunners had to live. In some ways the personnel considered themselves fortunate, for their site did at least have Nissen huts. Some batteries had to survive the winter of 1939-40 under canvas.

Over the nine months since it moved in, the battery had managed to clear the place up a bit. The long summer days had dried up much of the mud, but even a shower could turn everything soggy again. The gun pits remained dry by the constant efforts of the gunners, while the precious ammunition was always kept clean and dry in the specially-erected corrugated iron and sandbag shelters. Each pit was surrounded by a bank of extra sandbags set upon the concrete walls, and slit trenches, often full of water, were situated by each gun pit in case of sudden attack emergencies. The battery had had its share of those, for on many occasions the Luftwaffe had used the outline of the Thames estuary as a convenient navigational mark to point the way to London. As the massed formations winged their way towards London the battery was frequently in action, firing away as targets presented themselves. At times the battery itself became the focus of attention, German fighters swooping down to deliver a few bursts of machine-gun and cannon fire. The guns were virtually useless against such low-flying and fleeting targets so the battery had asked for and received two Lewis gun installations, each with four old Lewis guns mounted on a single pivot. These had been emplaced in their own special pits on each extreme edge of the site and competition to man them was intense.

The battery had been in action on nearly every day since June 1940. The early days of boredom and cold on the site had turned into periods of frantic activity or standing by the guns. Sometimes the gunners never saw the targets they were engaging as fire-control data were issued from a remote location away in the Medway towns to the south. On other days they could see their targets only too clearly as the huge formations of German bombers weaved their way through clear skies towards their main target of London. If they ever had time to watch, the gunners could see the delicate contrails of the defending Supermarine Spitfires and Hawker Hurricanes as they wove their way

An AA battery in action during the Blitz on London. To the right can be seen the small canvas, sandbag and corrugated iron ammunition shelter, with ready-use shells gleaming in the gun flash. Later in the war, the advent of radar control would make night firing much more effective.



The early stages of the Battle of Britain saw a determined German assault on the British defences, and anti-aircraft positions such as this battery in Kent had to do their best to camouflage their equipment.

through the massed bombers. Sometime they could see an aircraft falling out of the sky, at times followed by a parachute or two and at times not. But only rarely had they time to stand and watch.

Most of the gunners' time was taken up in serving the guns. The guns had to be laid, watching the pointer of the fire-control instruments and awaiting the signal to fire that came over the Tannoy loudspeaker or through the headset earphones. Ammunition had to be fed constantly into the gun, for every time the gun fired and recoiled, a new round had to be ready for loading as soon as the barrel ran back into the home position. The sheer handling of the bulky and heavy rounds soon reduced even the strongest men to shattered heaps and relays had to stand by to take over when anyone tired. And as if actually loading the gun were not in itself arduous enough, the ammunition still had to be carried from the magazines and dumps to the guns. This involved anyone who was to hand, from cooks to clerks. Even when action ended the magazines and ready-use ammunition dumps had to be replenished ready for the next action call which might come any moment.

It was this constant labour that the gunners were later to recall. Although they did not know it at the time, the Battle of Britain was being fought and won over their heads as they laboured away feeding shells into the ever-hungry guns. From time to time there was some light relief, such as the day when a Hurricane pilot from Biggin Hill dropped into the middle of the site on his parachute only to alight smack on top of the fire-control centre. Later in the day he flew past the site at low level in a new Hurricane waggling his wings in thanks. Then there was the day when a Messerschmitt Bf 110 decided to make a low-level attack when the gun crews were not actively engaging a target. The gunners could see him coming from miles off across the muddy wastes of the estuary and when he actually attacked every man who could grab a rifle fired away along with the Lewis guns. The Bf 110 made only one attacking pass and did no damage, but he flew away with smoke coming from one engine. The battery personnel never knew if they hit him or not, but they all felt a lot better after that episode.

A permanent battery on the fringes of London. Visible in the nearer emplacements are rangefinder and height finder, while in the background one of the guns awaits target data. In a site such as this, the four guns of the battery would be linked to the central fire control point by Tannoy or telephone.

During the middle of August the enemy action reached a crescendo. Wave after wave of bombers moved up the estuary only to fly back in smaller and more disorganized formations after the fighters had been among them. The battery remained in action for hours at a time and required a constant stream of ammunition supply trucks filing along the single narrow road that had been built to the site. After the middle of August the pace slackened a bit, but the raids continued to forge their way up the Thames. The peak had passed but the battery knew it not and laboured on in the fine sunny weather.

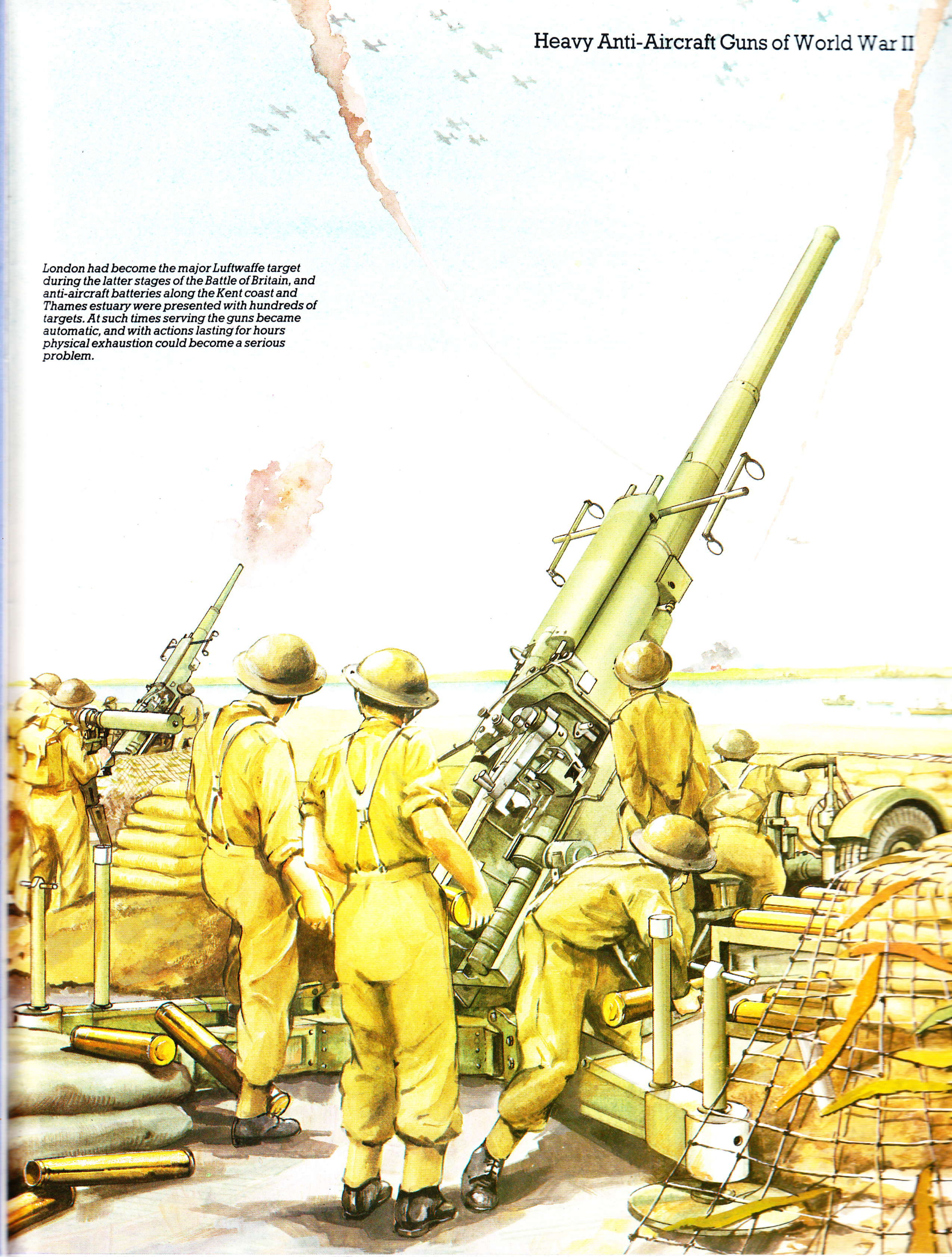
Night blitz

Then came a change. There were a few days at the beginning of September when no raids came. Time was spent on maintenance for the guns, and yet more ammunition was stockpiled. But suddenly the tempo and nature of the gunners' battle changed. The Luftwaffe attacked at night. They had done this before at odd times, but the new night attacks were on a much larger scale. The gunners had to fire blind. All they could do was lay the guns along fixed lines down which they hoped the enemy bombers would fly and they simply fired the guns as soon as they could be loaded. They rarely saw the enemy, despite the frantic activities of the searchlight batteries, and even if a target was suddenly caught in a beam it remained there for a short while only before weaving away from its attentions.

These night raids then started to come every night. Away to the west the fires started by the raids lit the sky and all through most days a pall of smoke hung over where London was burning. But the days brought no respite for the gunners. Small raids, sometimes of only two or three aircraft continued to sweep up the estuary, and these were engaged whenever they ventured into range. At all times the guns were kept manned in case of sneak or low-level attacks, and from time to time a solitary aircraft winged its way over following an attack on one of the Medway towns. Sleep became one of the gunners' major preoccupations. Nearly every night they had to work the guns and every day there were constant alarms and periods of action, to say nothing of the day-to-day routine of running the site and attending to everyday duties.

But although they did not yet know it, the gunners on that remote site had already played their part in winning the Battle of Britain. The Luftwaffe had been forced away from its chosen policy of massed daylight raids into the far more inaccurate and less effective night raids. All they could now hope to do was hit London, and London was a large city capable of absorbing a great deal of damage and casualties. The nights that followed that September were frequently full of danger and death but the worst was already past. After the winter of 1940-1 Hitler turned his attention to the east and the night raids simply faded away.

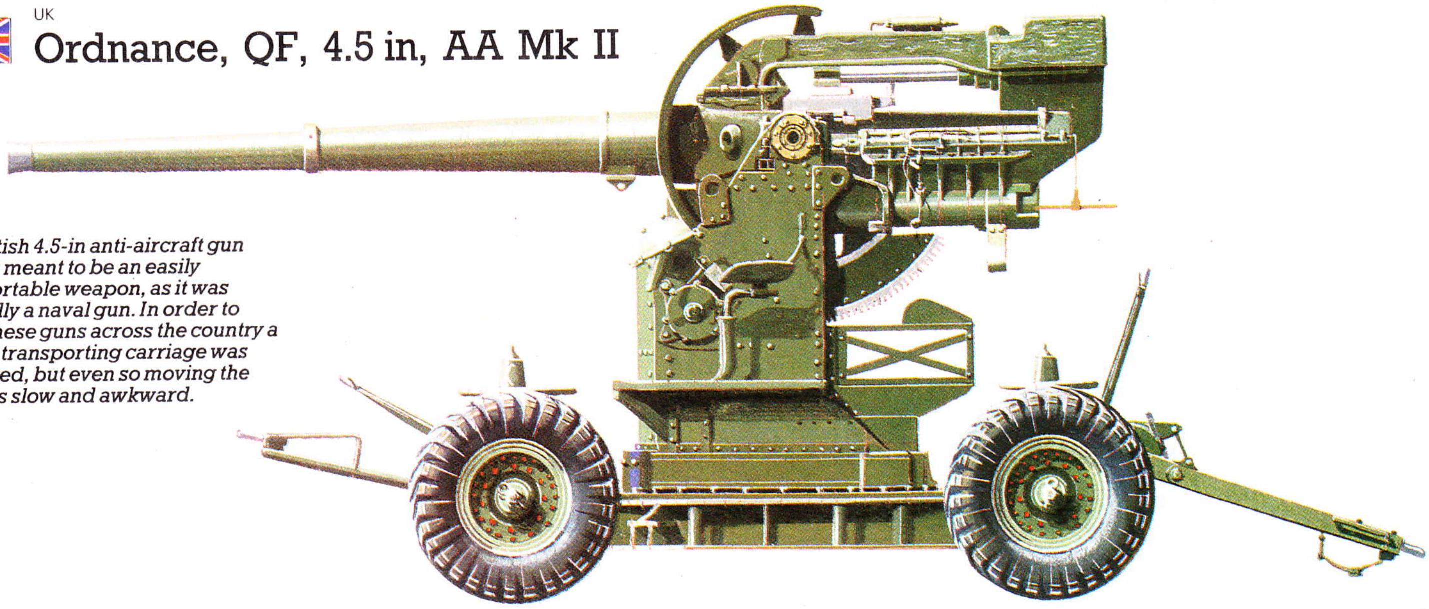
The gunners had done their bit.



London had become the major Luftwaffe target during the latter stages of the Battle of Britain, and anti-aircraft batteries along the Kent coast and Thames estuary were presented with hundreds of targets. At such times serving the guns became automatic, and with actions lasting for hours physical exhaustion could become a serious problem.

UK

Ordnance, QF, 4.5 in, AA Mk II



The British 4.5-in anti-aircraft gun was not meant to be an easily transportable weapon, as it was originally a naval gun. In order to move these guns across the country a special transporting carriage was produced, but even so moving the gun was slow and awkward.

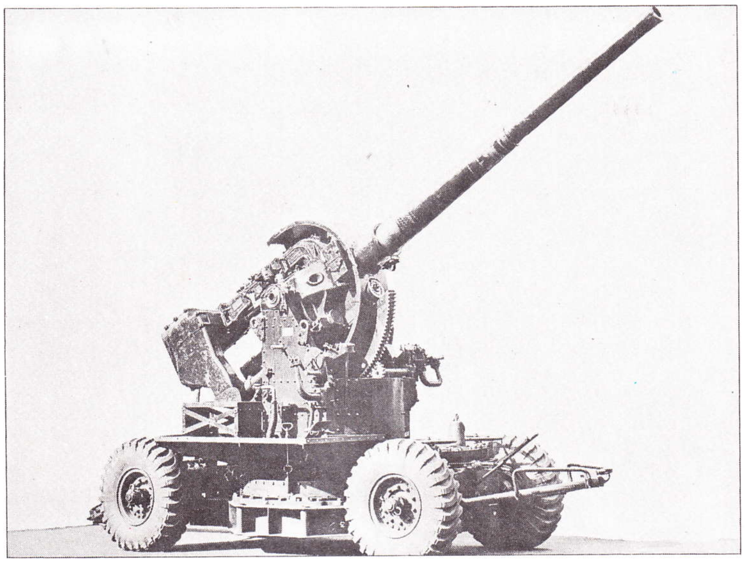
The gun that was to become the British army's 4.5-inch anti-aircraft gun had a rather muddled provenance, for it was actually a naval gun intended for use on board heavy vessels. It was undergoing acceptance trials in 1936 when it was decided that it would make an ideal anti-aircraft weapon for the army, and after some inter-service discussion the Admiralty agreed to divert some of its anticipated production to the army, but only on the understanding that the guns would be emplaced for the local defence of naval dockyards and other such installations. More muddle ensued when it was discovered by the army that the naval guns (actual calibre 113 mm/4.45 in) were intended for mounting in pairs. The army wanted single mountings, so time was lost while the necessary changes were made and tested.

When the type did eventually get into service (as the **Ordnance, QF, 4.5 in AA Mk II**) in time for the difficult days of 1940, it was emplaced as a static weapon only. Some measure of mobility could be provided by using a special heavy transporter trailer but such moves were difficult and lengthy, and required a great deal of preparation. Once emplaced, the guns demonstrated their naval origins by the retention of a turret-type mounting that rested on a base of heavy steel plate. The turret-type shelter over the gun had only limited protective value against steel splinters or falling shrapnel, but was welcome on some of the bleak gun-sites at which the weapons were located.

The gun had all the usual naval attributes, namely items such as a power rammer, a heavy counter-weight over the breech and a fuse setter on the loading tray. The ammunition handling equipment was very necessary, for each complete round weighed 38.98 kg (85.94 lb) and the movement of such weights over even a short period would soon have exhausted the ammunition handlers.

By 1941 the need to locate the guns around Admiralty-significant areas had been relaxed somewhat, allowing some of the guns to be relocated on stretches of coastline. There they could be used in a dual anti-aircraft/coastal defence role, but the numbers involved were never large as most of the guns remained in their static emplacements. These guns were issued with a special armour-piercing ammunition, but the projectiles generally fired were of the HE type, although there was a special but little-used shrapnel projectile intended for local defence against low-flying aircraft.

By 1944 it was intended that the gun should be phased out in favour of the more powerful 133-mm (5.25-in) weapon, but this never happened and some 113-mm (4.45-in) weapons were still in their static emplacements as late as 1951.



Originally produced as secondary armament for major warships, the 4.5-in retained some naval characteristics.

Specification

Ordnance, QF, 4.5 in, AA Mk II

Calibre: 113 mm (4.45 in)

Weight: emplaced 16841 kg (37,128 lb)

Dimensions: height of muzzle above ground emplaced (0° elevation) 2.438 m (8 ft) or (80° elevation) 7.163 m (23 ft 6 in); length of barrel 5.086 m (16 ft 8.25 in); length of rifling 4.341 m (14 ft 2.9 in)

Elevation: +80°/−0°

Traverse: 360°

Maximum ceiling: 12984 m (42,600 ft)

Shell weight: 24.7 kg (54.43 lb)

Muzzle velocity: 732 m (2,400 ft) per second

USA

3-in Antiaircraft Gun M3

When the USA decided to adopt an anti-aircraft gun during World War I it saved a great deal of development time by taking a couple of 76.2-mm (3-in) coast defence guns and adapting them for the new task. Two main versions emerged from this operation, one a static gun and the other a mobile gun using a basic form of platform mounting. In time the mobile mounting was used as the basis for a more modern mobile equipment, and starting in the mid-1920s a great deal of experimental and development work was carried out, the original M1918 coastal defence guns still being used as the basis.

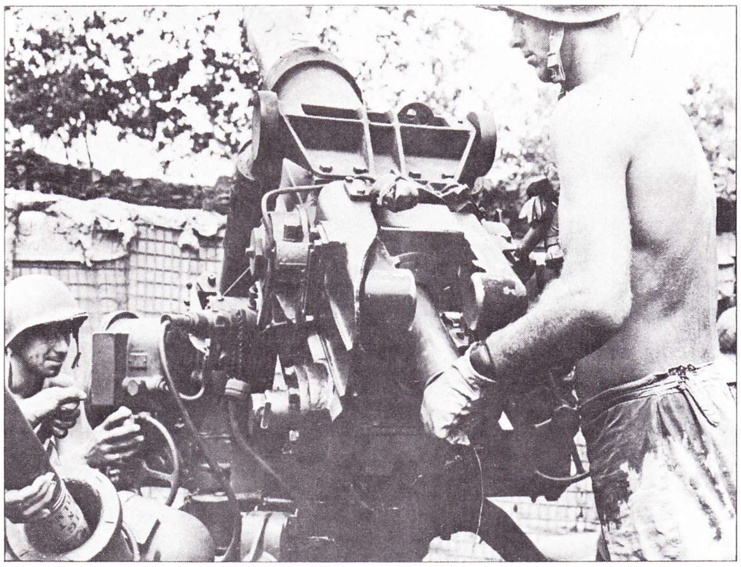
By the time that this development work had been completed, the original gun was virtually unrecognizable. The rifling had been changed and practically every other item on the gun was altered to some degree as well. The main trouble was that the gun itself proved to be far too difficult to make and required a great deal of machining to very close tolerances. Some redesign resulted in the **3-in Antiaircraft gun M3**, which also had a semi-automatic breech block. It was this gun that was standardized for use with the new mobile platform, itself the result of a great deal of development. The original World War I platform had been very much a 'rushed' job, and as such left much to be desired in the eyes of the US Army, which sought an ideal solution. In time this emerged as the carriage known as the M2 or 'Spider Mount': this was a pedestal mounting with a number of long outrigger legs over which a thick mesh platform was laid for the gun crew. The arrangement was certainly practical but the long outrigger legs, which folded upwards to the centre, took up a great deal of ground space.

By the mid-1930s it was obvious that the days of the M3 were coming to an end, and the basic design was once again revamped in an effort to secure better performance. An entirely new 90-mm (3.54-in) design was already on the way, however, and thus the revamped M3 did not prosper. Instead the existing equipments were gradually withdrawn from front-line use as the new 90-mm (3.54-in) guns appeared. This took time, and when the USA entered the war in 1941 the old M3 was still in use in the Philippine Islands, where the weapons were used as long as the islands held out. Some lingered on for a while in other Pacific areas, and during early 1942 some were paraded through US west coast towns and cities in a programme to boost civilian morale. These west coast guns were culled mainly from training stocks, for by early 1942 the M3 was in use as a training gun only. Many of the gunners who subsequently went on to man the 90-mm (3.54-mm) guns started their service training using up the existing ammunition stocks for the M3 guns. Once this training role had been completed the old guns still found a use, for many were removed from their Spider Mountings and renovated for use as the barrels for the M5 anti-tank gun. For this role the breech of the 105-mm (4.13-in) M2 howitzer was used, and thus the old anti-aircraft guns went on to a new service career.

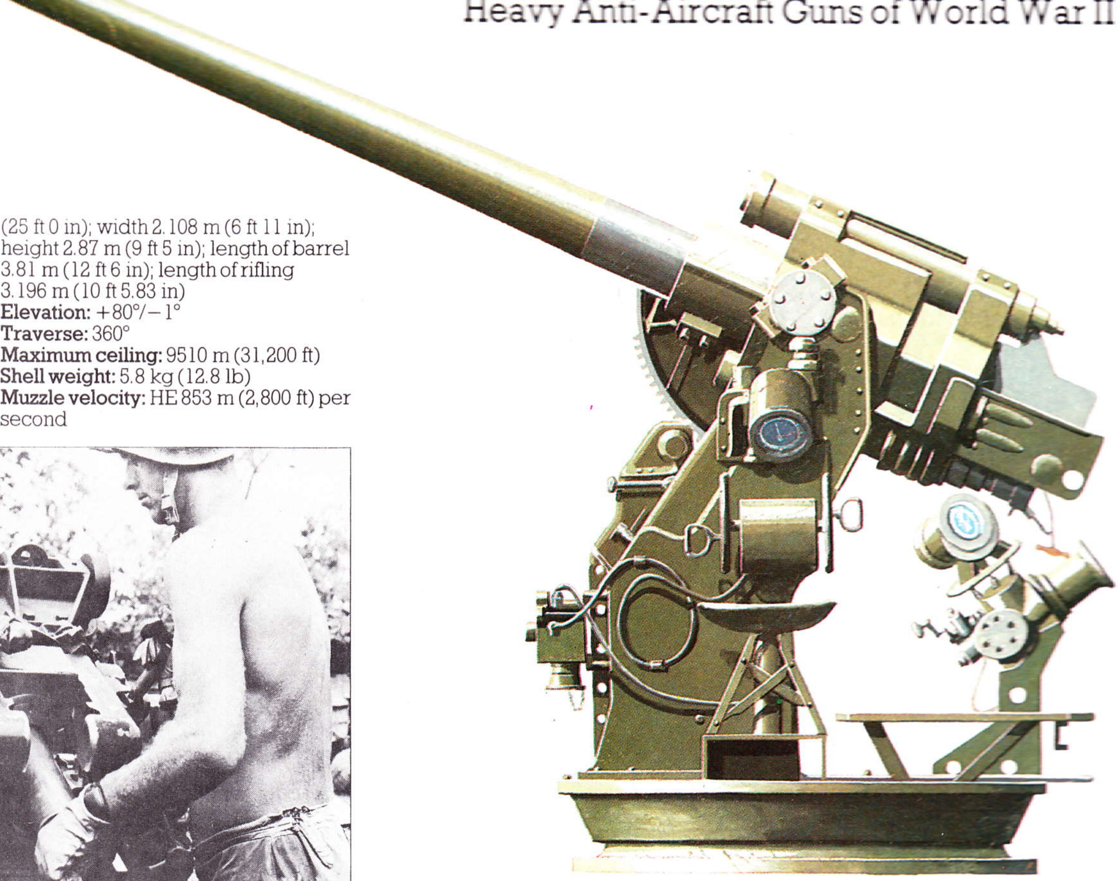
At one point in the days immediately after Dunkirk there were plans to sell numbers of M3 guns to the United Kingdom to replenish AA guns lost at Dunkirk, but in the event none made the Atlantic crossing.

Specification

3-in Antiaircraft Gun M3 on Mount M2A2
Calibre: 76.2 mm (3 in)
Weight: complete 7620 kg (16,800 lb)
Dimensions: length travelling 7.62 m (25 ft 0 in); width 2.108 m (6 ft 11 in); height 2.87 m (9 ft 5 in); length of barrel 3.81 m (12 ft 6 in); length of rifling 3.196 m (10 ft 5.83 in)
Elevation: +80°/−1°
Traverse: 360°
Maximum ceiling: 9510 m (31,200 ft)
Shell weight: 5.8 kg (12.8 lb)
Muzzle velocity: HE 853 m (2,800 ft) per second



Left: The M3 was by 1941 largely relegated to home defence, as many of the guns dated back to World War I. Some did see action in the Far East during 1942, however.



Above: In 1941 the American 3-in (76.2-mm) gun was still in service in several forms. This static version was the 3-in Gun M4 on Mount M3, and was used in such locations as the Philippines and the Canal Zone.

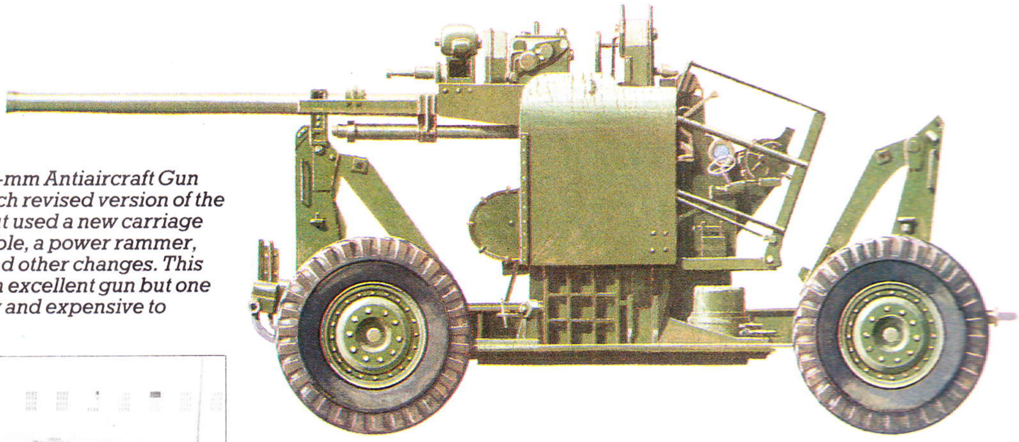
USA

90-mm Gun M1

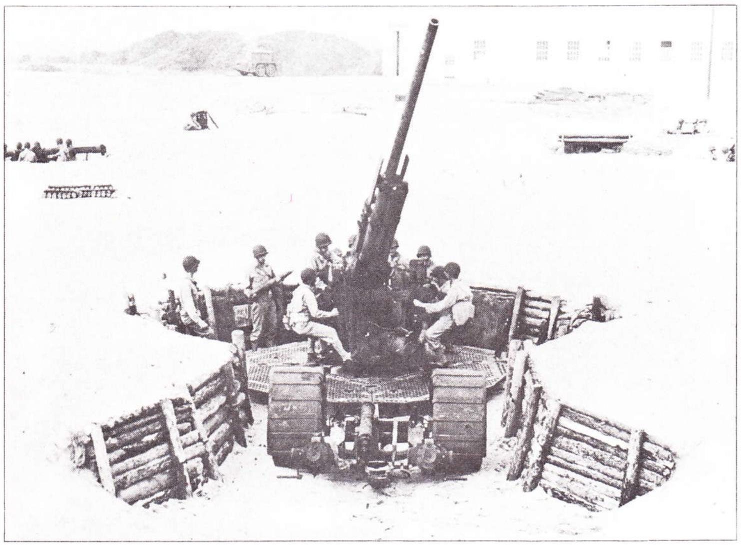
Once it was realized that the old 76.2-mm (3-in) anti-aircraft guns were coming to the end of their service life during the late 1930s, it was decided by the US Army to produce a weapon not only with a better performance but one capable of firing a heavier projectile. Since a 90-mm (3.54-in) projectile was considered the upper weight limit of what a soldier could handle manually this was fixed as the new calibre, and design work began in 1938. By 1940 the prototypes were approved for service use as the **90-mm Gun M1 on Antiaircraft Mount M1A1**, and production commenced with a high priority cachet.

The M1 was a handsome but a rather complex weapon which proved difficult to produce. The gun assembly itself was straightforward, but the carriage was another matter. It was designed to be towed on a single axle with two pneumatic tyres on each side, and in action it stood on a cruciform mounting with the crew standing around the gun on a folding platform. The problem was to get all this carriage and platform folded onto the single axle. The result can be described only as complicated.

Soon after the M1 gun was placed in production it was supplemented by the **M1A1**, which had provision for the fitting of a spring rammer. In practice this rammer proved to be more trouble than it was worth and was usually removed, but another change was on the way. In July 1941 it was decided that in future the 90-mm (3.54-in) gun and carriage would have to be capable of engaging sea and land targets as well. This meant a revision of the carriage as on the M1 carriage the gun could not



Right: The 90-mm Antiaircraft Gun M2 was a much revised version of the earlier M1 but used a new carriage with a turntable, a power rammer, fuse setter and other changes. This resulted in an excellent gun but one that was slow and expensive to produce.



This 90-mm M1 anti-aircraft gun is dug in to take part in beach defences. Other emplacements can be seen, including one at the left rear containing the battery's rangefinder and other fire control equipment. The mount is the M1A1; the later M2 mount used a turntable.

be depressed below 0°, and the opportunity was taken to incorporate a radical redesign. The M2 carriage had a totally different design with a low firing platform carried on four outrigger legs when firing. It was much handier and quicker to get into action, and some versions also had a small shield. The main change, however, was to the gun, which became the M2 in which the ammunition feed for a new fuse setter and rammer was added, this making fuse setting much more rapid and accurate, and also raising the rate of fire to a possible 27 rounds per minute. Yet more accuracy and lethality was added in late 1944 when the 90-mm (3.54-in) gun was used as one of the first weapons on land to fire the new proximity-fused round, one of the most advanced weapon developments of the war years. Using this fuse one gunner managed to shoot down a Focke-Wulf Fw 190 fighter with a single shot as the unfortunate aircraft attempted to intervene in the Ardennes campaign. The 90-mm (3.54-in) gun and the proximity fuse were also instrumental in the defeat of the V-1 flying bombs over southern England.

The 90-mm (3.54-in) gun in all its forms was manufactured in large numbers. By August 1945 a total of 7,831 of all types had been produced. This included some guns intended for static mounting only, and some guns were indeed used around the coasts of the continental USA in a dual anti-aircraft/coastal role.

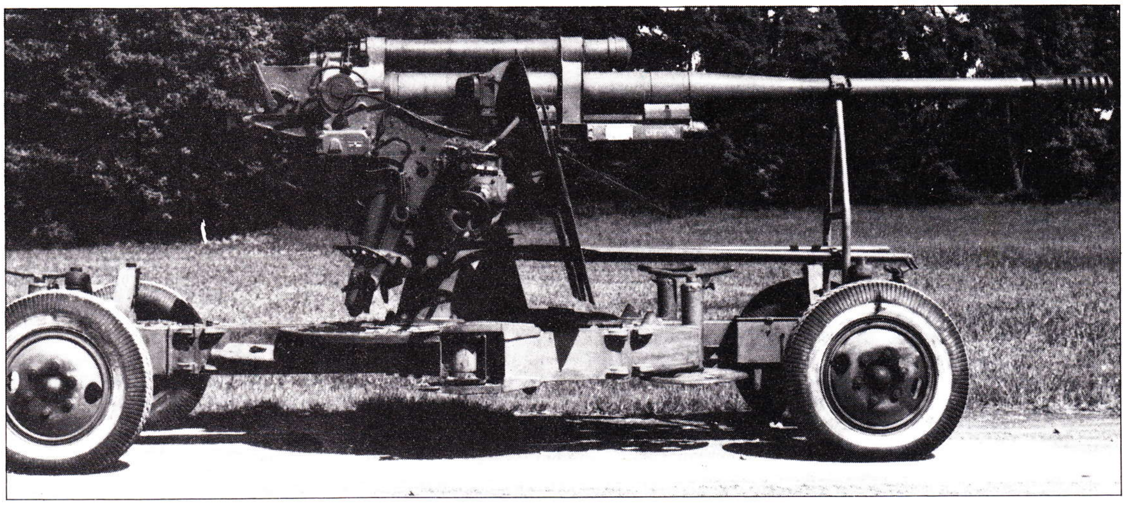
The 90-mm (3.54-in) gun was also used in a purely coast defence mounting in a special armoured turret, and at one stage it was proposed that these turrets would even have their own automatic loaders, thus removing the need for men to crew them in action as they would be aimed and fired by remote control. The 90-mm (3.54-in) gun was also used in M36 tank destroyers mounted on Sherman chassis, and there were several advanced designs involved in the production of a towed 90-mm (3.54-in) anti-tank gun, but none of these saw service.

Specification

90-mm Gun M2 on Mount M2
Calibre: 90 mm (3.54 in)
Weight: complete 14651 kg (32,300 lb)
Dimensions: length travelling 9.021 m (29 ft 7.15 in); height 3.073 m (10 ft 1 in); wheelbase 4.166 m (13 ft 8 in); length of barrel 4.50 m (14 ft 9.2 in)
Elevation: +80°/−10°
Traverse: 360°
Maximum ceiling: 12040 m (39,500 ft)
Shell weight: 10.6 kg (23.4 lb)
Muzzle velocity: 823 m (2,700 ft) per second

USSR

The Soviet 85-mm guns



The 85-mm anti-aircraft gun was developed from the successful 76.2-mm series, and proved highly effective in service. Much prized by the Germans, captured equipment was used alongside the famous '88'. Many were used in the defence of Germany from the Allied bombing campaign.

By the late 1930s the Soviet armed forces, in common with many other armed forces of the time, decided that the anticipated increases in aircraft performance over the next few years would soon render their current anti-aircraft weapons obsolete. Accordingly they set about looking for a more modern anti-aircraft gun with a better all-round performance, but, in typical Soviet fashion, instead of designing a new weapon they used an old design as the basis for a new weapon. They simply took the 76.2-mm (3-in) Model 1938 and enlarged it all round to become an 85-mm (3.346-in) gun. The new gun was designated the 85-mm **Anti-Aircraft Gun Model 1919**, and is sometimes known as the **KS-12**.

The Model 1939 was very similar to the 76.2-mm (3-in) Model 1938, but could be easily recognized by its multi-baffle muzzle brake, a feature lacked by the 76.2-mm (3-in) gun. A shield was an optional extra. Production of the Model 1939 was just getting under way at Kaliningrad, near Moscow, when the Germans invaded in 1941, so the entire plant was moved to the Urals for the rest of the war. Once back in production the Model 1939 became the standard heavy anti-aircraft gun of the Red Army, though it was replaced in production during 1944 by the more powerful **85-mm Anti-Aircraft Gun Model 1944** or **KS-18**. This was virtually the same weapon as the Model 1939, but could use a more powerful charge to boost all-round performance with the same projectile as that of the Model 1939.

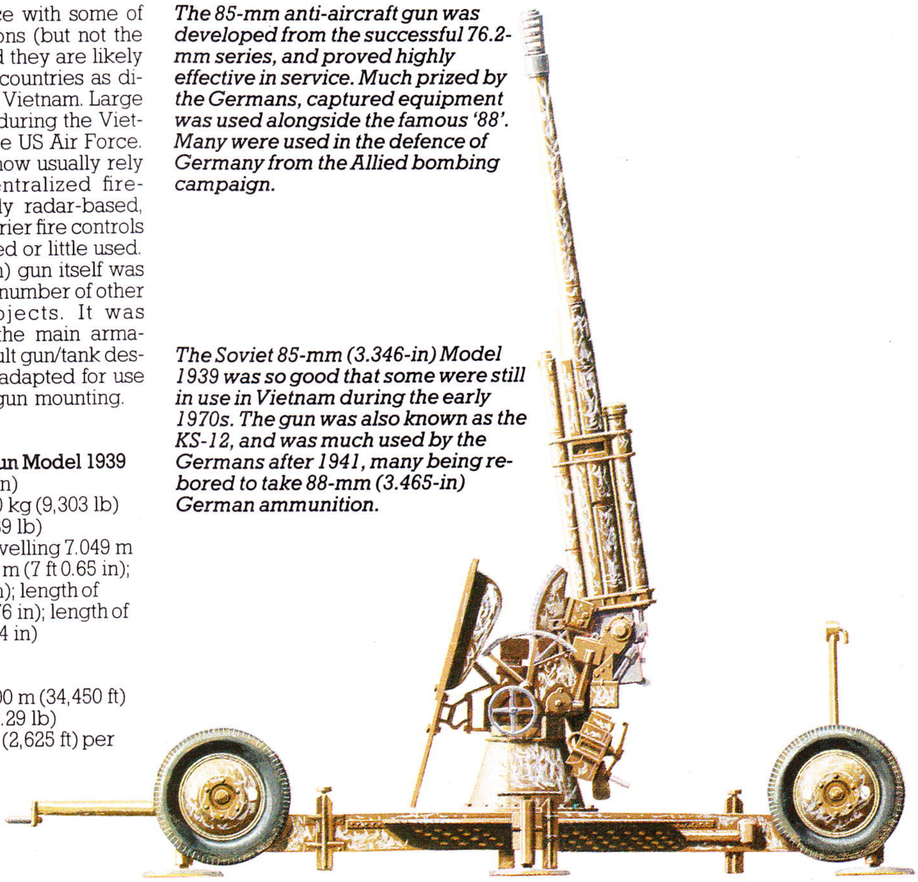
Both the Model 1939 and the Model 1944 were designed from the outset to be used as anti-armour weapons in the same manner as the German '88'. They were so successful in this role that the Germans prized them as war booty and used any captured examples alongside their own 88s under the designations **8.5-cm Flak M.39(r)** and **8.5-cm Flak M.44(r)**. As with the Soviet 76.2-mm (3-in) guns, captured examples were also shipped back to the Reich for home defence, where they were rebored to the standard German 88 mm (3.465 in) once all captured ammunition stocks had been expended. Most of the guns used in this way by the Germans were Model 1939s, which became **8.5/8.8-cm Flak M.39(r)** guns.

The Model 1939 and the Model 1944 were both good anti-aircraft guns, and this is attested by the fact that many are still in active service to this day. Numbers are still in service with some of the Warsaw Pact nations (but not the Soviet Union itself) and they are likely to be encountered in countries as diverse as the Sudan and Vietnam. Large numbers were active during the Vietnam conflict against the US Air Force. These 'modern' guns now usually rely on some form of centralized fire-control system, usually radar-based, and the original on-carrier fire controls are now either removed or little used.

The 85-mm (3.346-in) gun itself was used as the basis for a number of other Soviet weapon projects. It was adopted to become the main armament of the SU-85 assault gun/tank destroyer, and was even adapted for use on a towed anti-tank gun mounting.

Specification

85-mm Anti-Aircraft Gun Model 1939
Calibre: 85 mm (3.346 in)
Weight: travelling 4220 kg (9,303 lb) and firing 3057 kg (6,739 lb)
Dimensions: length travelling 7.049 m (23 ft 1.5 in); width 2.15 m (7 ft 0.65 in); height 2.25 m (7 ft 4.6 in); length of barrel 4.693 m (15 ft 4.76 in); length of rifling 3.494 m (11 ft 5.54 in)
Elevation: +82°/−2°
Traverse: 360°
Maximum ceiling: 10500 m (34,450 ft)
Shell weight: 9.2 kg (20.29 lb)
Muzzle velocity: 800 m (2,625 ft) per second



The Soviet 85-mm (3.346-in) Model 1939 was so good that some were still in use in Vietnam during the early 1970s. The gun was also known as the KS-12, and was much used by the Germans after 1941, many being re-bored to take 88-mm (3.465-in) German ammunition.

Part 4

US Marine Corps

US Marine Corps Order of Battle

US Marine divisions are deployed with Marine Aircraft Wings, Support Groups and Marine brigades to form fleet amphibious forces; combined arms units ready for battle anywhere in the world.

HQ MARINE CORPS, WASHINGTON DC

- FLEET MARINE FORCE ATLANTIC
- FLEET MARINE FORCE PACIFIC
- FLEET MARINE FORCE EUROPE (DESIGNATE)
- MARINE CORPS AIR GROUND COMBAT CENTER
- MARINE CORPS RESERVE

FLEET MARINE FORCE ATLANTIC (FMFLANT), NORFOLK, VA

- **II Marine Amphibious Force, Norfolk, Va**
  - 4th Marine Amphibious Brigade
  - 22nd Marine Amphibious Unit, Camp Lejeune, NC
  - 26th Marine Amphibious Unit, Camp Lejeune, NC
  - 28th Marine Amphibious Unit, Camp Lejeune, NC
- **2nd Marine Division, Camp Lejeune, NC**
  - 6th Marine Amphibious Brigade
  - 2nd Marines
  - 6th Marines
  - 8th Marines
  - 10th Marines (Artillery)
  - 2nd Assault Amphibian Battalion
  - 2nd Combat Engineer Battalion
  - 2nd Reconnaissnce Battalion
  - 2nd Tank Battalion
- **2nd Force Service Support Group**
- **4th Marine Division (Reserve), New Orleans, La**

FLEET MARINE FORCE PACIFIC (FMFPAC), CAMP H.M. SMITH, HI

- **I Marine Amphibious Force**
- **III Marine Amphibious Force**
- **31st Marine Amphibious Unit**
- **37th Marine Amphibious Unit**

- **1st Marine Division, Camp Pendleton, Ca**
  - 1st Marines
  - 5th Marines
  - 7th Marines
  - 11th Marines (Artillery)
  - 3rd Assault Amphibian Battalion, Camp Pendleton, Ca
  - 1st Combat Engineer Division
  - 1st Reconnaissance Battalion
  - 1st Tank Battalion
- **1st Field Service Support Group**
- **1st Marine Brigade, Kaneohe, HI**
  - 3rd Marines
  - Brigade Service Support Group
- **3rd Marine Division, Okinawa, Japan**
  - 4th Marines
  - 9th Marines
  - 12th Marines (Artillery)
  - 3rd Combat Engineer Battalion
  - 3rd Reconnaissance Battalion
  - 1st Tracked Vehicle Battalion
  - 7th Communication Battalion
- **3rd Field Service Support Group**

MARINE CORPS AIR GROUND COMBAT CENTER (MCAGCC), TWENTY-NINE PALMS, CA

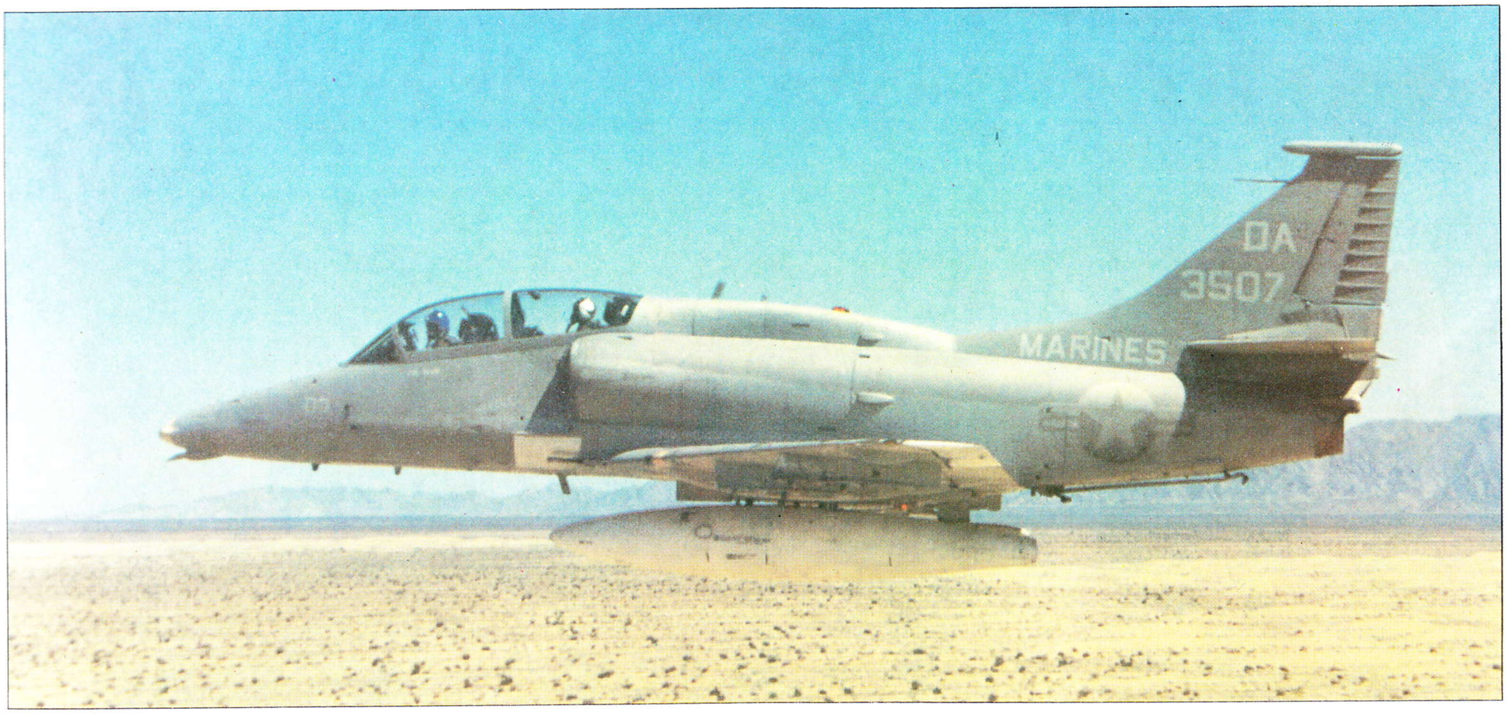
- **7th Marine Amphibious Brigade**
  - 27th Marine Regiment
  - 1st Battalion, 4th Marines
  - 3rd Tank Battalion
  - 1st Light Armoured Vehicle Battalion

MARINE CORPS RESERVE

- **4th Marine Division, New Orleans, La**
  - 14th Marines, Dallas, Tx
  - 23rd Marines, Alameda, Ca
  - 4th Force Service Support Group, Atlanta, Ga
  - 4th Assault Amphibian Battalion, Tampa, Fla
  - 4th Combat Engineer Battalion, Baltimore, Md
  - 1st Battalion, 23rd Marines, Houston, Tx
  - 2nd Battalion, 23rd Marines, Encino, Ca
  - 3rd Battalion, 23rd Marines, New Orleans, Tx
  - 1st Battalion, 24th Marines, Detroit, Mich
  - 2nd Battalion, 24th Marines, Chicago, Il
  - 3rd Battalion, 24th Marines, St Louis, Mo
  - 1st Battalion, 25th Marines, Camp Edwards, Ma
  - 2nd Battalion, 25th Marines, Long Island, NY
  - 3rd Battalion, 25th Marines, Cleveland, Oh
  - 4th Reconnaissance Battalion, San Antonio, Tx
  - 4th Tank Battalion, NAS Miramar, Ca
  - 8th Tank Battalion, Rochester, NY
  - 1st Battalion, 14th Marines (Artillery), Los Angeles, Ca
  - 2nd Battalion, 14th Marines (Artillery), Dallas, Tx
  - 3rd Battalion, 14th Marines (Artillery), Philadelphia, Pa
  - 4th Battalion, 14th Marines (Artillery), Bessemer, Al
  - 5th Battalion, 14th Marines (Artillery), San Francisco, Ca

12 PASS

US Marine Corps Order of Battle



Beginning life as a TA-4F trainer, this McDonnell Douglas OA-4M Skyhawk is issued as a 'fast-mover' FAC (Forward Air Control) aircraft, flying over the battlefield controlling and marking targets for the main aerial strike force.

Marine Aircraft Groups

MCCRTG-10 Yuma, Az fighter/attack training
MAG-11 El Toro, Ca VMFA/VMFP
MAG-12 Iwakuni, Japan VMA/VMA(AW)/VMAQ
MAG-13 El Toro, Ca VMA/VMA(AW)
MAG-14 Cherry Point, NC VMA(AW)
MAG-15 Iwakuni, Japan VMFA/VMFP
MAG-16 Tustin, Ca HMA/HMH/HMM/HML/VMO
MAG-24 Kaneohe Bay, HI composite helicopter/fighter-attack
MAG-26 New River, NC HMH/HMM
MWSG-27 Cherry Point, NC VMGR
MAG-29 New River, NC HMA/HML/VMO
MAG-31 Beaufort, SC VMFA
MAG-32 Cherry Point, NC VMA
MAG-36 Futenma, Okinawa composite helicopter
NWSG-37 El Toro, Ca VMGR

1st MAW

MAG-12, MAG-15, MAG-36

2nd MAW

MAG-14, MAG-26, MWSG-27, MAG-29, MAG-31, MAG-32

3rd MAW

MCCRTG-10, MAG-11, MAG-13, MAG-16, MWSG-37

1st MB

MAG-24

USMC FLYING UNITS

VMFA-115 (F-4S)
VMFA-122 (F-4S)
VMFA-212 (F-4S)
VMFA-232 (F-4S)
VMFA-235 (F-4S)
VMFA-251 (F-4S)
VMFA-251 (F-4S)
VMFA-312 (F-4S)
VMFA-314 (F-18A)
VMFA-323 (F-18A)
VMFA-333 (F-4S)
VMFA-451 (F-4S)
VMFA-531 (F-18A)
VMA-211 (A-4M)
VMA-214 (A-4M)
VMA-223 (A-4M)
VMA-231 (AV-8)
VMA-311 (A-4M)
VMA-331 (A-4M)
VMA-513 (AV-8)
VMA-542 (AV-8)
VMA(AW)-121 (A-6E)
VMA(AW)-224 (A-6E)
VMA(AW)-242 (A-6E)
VMA(AW)-332 (A-6E)
VMA(AW)-533 (A-6E)
VMO-1 (OV-10A/D)
VMO-2 (OV-10A/D)
VMGR-152 (KC-130F)
VMGR-252 (KC-130F/R)
VMGR-352 (KC-130R)
VMFP-3 (RF-4B)
VMAQ-2 (EA-6B)
VMFAT-101 (F-4J/S)
VMAT-102 (A-4M, TA-4J)
VMAT(AW)-202 (A-6E, TC-4C)
VMAT-203 (AV-8A, TAV-8A)
HMM-161 (CH-46)
HMM-162 (CH-46)
HMM-163 (CH-46)
HMM-164 (CH-46)
HMM-165 (CH-46)
HMM-261 (CH-46)
HMM-262 (CH-46)
HMM-263 (CH-46)
HMM-264 (CH-46)
HMM-265 (CH-46)
HMM-365 (CH-46)
HMH-361 (CH-53D)
HMH-362 (CH-53D)
HMH-363 (CH-53D)
HMH-364 (CH-53E)
HMH-461 (CH-53D)
HMH-462 (CH-53D)
HMH-463 (CH-53D)
HMH-464 (CH-53E)
HMA-169 (AH-1T)
HMA-269 (AH-1T)
HMA-369 (AH-1T)
HML-167 (UH-1N)
HML-267 (UH-1N)
HML-268 (UH-1N)
HMX-1 (CH-46, CH-53, UH-1N) (see note)
HMT-201 (AH-1J/T)
HMT-204 (CH-46/53)
HMT-301 (CH-46/53)

Note: HMX-1 also maintains an Executive Flight Detachment with the VH-1N, VH-3A, VH-46 and VH-53D for use by the President of the United States

The Marine Corps have procured the McDonnell Douglas F/A-18 Hornet to augment and finally replace the Vought A-7 Corsair II and McDonnell Douglas F-4 Phantom II. Here an F/A-18A with practice AIM-9L Sidewinders approaches the ramp of a carrier.